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WORLD FISHERIES YEAR-BOOK AND DIRECTORY 1948

Incorporating the

NORTH ATLANTIC FISHERIES YEAR-BOOK

and the

HERRING EXPORTERS MANUAL

Edited by

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BRITISH-CONTINENTAL TRADE PRESS LTD.

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The North Atlantic Fisheries
Year-Book was first
published in
1936

PREFACE

TEN years have passed since the North Atlantic Fisheries Year-book was last published and it now emerges strengthened and widened in scope, as the "World's Fisheries Year-Book." This has come about as a result of the widespread demand for a comprehensive Guide to the World's fisheries, and has become reality through the willing co-operation of authorities, firms and individuals to whom we express our thanks and appreciation.

In the interests of national economy and owing to the paper restrictions, the dislocation of trade and transport and the changes brought about by the war, we have been prevented from presenting this book as attractively and as large a volume as we should have liked.

A great amount of work was required to obtain and include all the information, facts and figures compressed into this small book. Owing to the large pressing demand after the war, when all the Directors of this publishing company were on active service, there was not much time to revise the North Atlantic Fishery Year-Book now incorporated in this volume, and to enlarge the information to cover the world fishing industry and international fish trade as a whole. We therefore ask and hope for the indulgence of our readers and friends throughout the world. For the future a great deal will depend on their co-operation to make this reference work more useful and comprehensive. The Editor, anxious to improve the contents in every way, invites and welcomes suggestions and criticism.

Readers are requested to make sure that the entries concerning their firms, particularly in the Directory section, are correct and up to date. No responsibility is taken for the entries published, which are based on questionnaires completed by the respective firms, and on information supplied from official sources.

Finally, this book has no connection whatsoever with any other book on the subject of fisheries, nor have the publishers an interest in any other book on this subject.

JANUARY, 1948. THE PUBLISHERS.

PROGRESS AND OPPORTUNITY

BY THE EDITOR

THE changes and rate of development experienced in fishing and the fish trade during the past decade have been unprecedented since the introduction of steam trawling. In fact, the revolutionary character of quick-freezing and the use of the so-called factory ships may have an even greater effect on fish supply and demand than did the introduction of engine-driven boats in the fishing industry.

It does not require much imagination to realise that the day will soon come when fish will be quick-frozen, filletted and packed on board ship, landed and distributed from ports to consuming centres far inland in containers which will keep the quality and freshness of fish in perfect condition. Air transport is already being used in the service of fish distribution, and this will mean a further widening of the markets, and will add to the variety of fish available to remote inland consumers.

The fishery industries throughout the world have a unique opportunity to establish fish as a regular item in the diet of every nation, and to make it a commodity as much in demand as sugar, tea, coffee—possibly as highly valued as bread, meat and fruit. One does not often realise that only a century or two ago the first mentioned food items were practically unknown to the general public; yet today one cannot imagine that hundreds of millions of people in all continents could exist without daily consumption of tea, coffee or sugar. Why then should not fish appear regularly on the menu of every household throughout the World? Previously, there were good reasons for a lack of popularity: insufficient hygienic conditions in fish storage, packing and shop display, and the resultant deterioration in the attractiveness of fish in the retail trade and catering industry. As recently as 1938, fish was loaded from ships' holds and docks after exposure to sun and air into trucks which were none too hygienic, packed in boxes not properly cleaned after previous use, and so on. Under these conditions the public had hardly the opportunity to appreciate the excellent taste and nutritious value of fresh fish!

Those days are over and it is gratifying to state that the fish trade realises the changes that have come. On its part it is doing all it can to improve these conditions by the introduction of quick-freezing, refrigerated ships and trucks, improved processing, almost perfect packing, and greater care in the retail trade. The auxiliary industries are helping the fishing industry by producing the machinery, equipment and material required and by co-

operating with the industry in achieving nigh perfection in this field.

There are certain important features beyond the control of the fishery industries, however. First, if quick-freezing is to increase food supplies by adding large quantities of fish to the general diet, governments and transport authorities will have to provide refrigerated rail and road trucks for inland distribution of frozen fish. Secondly, steel and other materials so vital for the manufacture of freezing plants and equipment will have to be available for this purpose in larger quantities than during the past two years.

While the majority of the world's population is near starvation level and crying out for food of every kind, fish is available in almost unlimited quantities. It is true that there is the problem of overfishing in certain areas, but this could be overcome with some goodwill of the principal fishing nations concerned. On the other hand, planned and controlled fishing, on the lines of the whaling season, could be attempted.

One more task has to be performed; the education of retailers *and the public in regard to fish varieties, their characteristics and* ways of cooking and preparing them. It is for this purpose that a chapter has been incorporated in this book which deals with this subject. It is now up to food authorities and trade associations in various countries, and depends largely on the co-operation of the distributors, how far and how fast progress will be made in making the public appreciate the excellence of fish.

WORLD SURVEY

THE world's total catch of fish before the last war is estimated to have amounted to approximately 18 million tons per year. This estimate has been made by the staff of the Food and Agriculture Organisation of the United Nations. Members of the study group dealing with the fisheries industry were, however, handicapped by incomplete returns due to the failure of some Governments to supply the relevant information.

Only about 40 per cent. of the world's fish production of fish for human food—12 million tons—is edible weight, i.e., 5 million tons. The report mentioned above states that in order to obtain a clear picture of fish consumption, distribution must be taken into consideration. Consumption among the maritime populations near the great fisheries is very much higher than among peoples who live far from the sea. Bases of calculations are too variable to permit an accurate comparison of the data of one country with that of another. However, as an indication of the spread, it is estimated that pre-war Japanese consumption was some forty kilograms per caput annually, as compared with a consumption in India of three kilograms per caput for those who eat fish.

Fisheries of most of the major producing countries are rapidly recovering from the effects of the war. With the exception of France and Germany, production in the countries of North-western Europe approached, and in some cases exceeded, that of pre-war as can be seen from the following table:—

	Thousands of Metric Tons.*		
	Pre-War Avge.		1946
Norway	935	1930-39	835
United Kingdom	1070	1938	920
Denmark	107	1939	190
Belgium	39	1938	70
Netherlands	240	1936-38	190†
France	400	1938	250
Germany	650	1937-38	260††
Sweden	130	1939	200§
Iceland	290	1935-37	370
Totals	3861		3285

*Metric tons used throughout the report.

†Estimated.

††Pre-war figure applies to all of Germany: 1946 figure applies to Anglo-American zones.

§Estimated.

Fish production of the Balkans and Central and Eastern Europe, which has always been low, remains below the pre-war average. U.N.R.R.A. shipped about 220,000 tons of fish and fish oils into these areas.

In North America, fish production remained at a relatively high level, the Canadian production reaching an all-time record of some 610,000 tons, landed weight, and the United States and Alaska having produced some two million tons, or slightly below the 1941-45 average.

Landings in Newfoundland reached 350,000 tons, which is somewhat above the pre-war output. Production increased during the war period in Latin America and is still increasing, particularly in Brazil, Peru and Venezuela. Little statistical information is available on the fisheries in the Far East, but it is known that in most of the Far Eastern countries, because of destruction of boats and gear, catches are below the low level of pre-war.

In 1946, Japanese production was approximately three million tons, landed weight, and since all of the supply was retained for domestic use, consumption approached pre-war levels.

Indications are that world fish production, while increasing steadily since the end of the war, has not yet reached pre-war levels. Furthermore, war-time changes, e.g., diversion from preserved to fresh and frozen, have given rise to certain post-war distribution problems, the economic and technical phases of which call for prompt action.

CANNED FISH

Canned fish, the distribution of which had been the subject since 1944 to the recommendations of the Combined Food Board and International Emergency Food Council, was removed from allocation recommendation on April 1, 1947, after the bulk of the 1946-7 pack had been contracted for or delivered.

Production in 1946-47 was approximately 455 thousand tons, of which 202 thousand tons were available for export, compared with an exportable surplus of some 295 thousand tons pre-war. The absence of export supplies from Japan, which amounted to some 90 to 115 thousand tons annually before the war, accounts largely for the drop in supply. The Portuguese supply, also, showed a decline of some 40 per cent. below the pre-war level, due to the shortage of tinplate and other ancillary materials. Exports from the United States and Canada, while somewhat below the level of 1945-46 due to the poor salmon and pilchard packs in the United States on the one hand and some increase in domestic consumption on the other, were still about 60 per cent. higher than pre-war.

The supply of canned fish in 1947-48, according to information available to the I.E.F.C., is estimated at 515,000 tons, of

which some 210,000 is expected to be available for export. This export figure takes into account possible shipments of up to 22,000 tons of canned fish from Canada, as well as a quantity from the United States for post-U.N.R.R.A. European relief.

No information is forthcoming on the availability to canned fish from the U.S.S.R. in 1947-48 although, according to reports, 5,700 tons of canned salmon and crab meat were purchased for export, presumably from the 1946-47 pack.

It is not anticipated that any substantial quantities of canned fish will be exported from Japan in 1948.

CANNED EXPORTABLE SURPLUS

	Metric Tons.		
	1937	1946-47	1946-48
U.S.A.	43,200	69,100	64,300
Canada	37,400	59,200	57,800
Japan	110,850	—	—
Portugal	50,000	27,700	27,700
Norway	36,300	15,600	22,700
Spain	8,400	6,400	6,300
United Kingdom ...	3,000	340	3,200
Others	5,600	23,400	28,000
	294,750	201,740	210,000

SALTED COD.

The main exporting countries of salt fish are Norway, Denmark (including the Faroe Islands and Greenland), Iceland, Newfoundland, and Canada, while market outlets are found in the Caribbean, South America, the Iberian Peninsula and the Mediterranean. Salted fish is a low-priced, concentrated protein food containing sodium chloride suitable for the diet of people who live in hot countries, and in some of these countries the consumption of salted cod forms part of a long-established dietary pattern.

During World War II., Norway's exportable surplus was no longer available to her historical markets and with the shift in production in certain other countries, e.g., Iceland and the Faroe Islands, available world supplies declined by about 60 per cent. On the recommendation of the Combined Food Board, the distribution was controlled, beginning with the 1943 production and uniform export prices were established.

These controls were maintained for the 1944 and 1945 exportable surpluses, but with the reappearance of Norway as a major supplier, and the consequent improvement in supplies in 1946, uniform prices were not maintained. Allocations were continued for the 1946 production and were terminated on June 30, 1947.

Exportable supplies from the 1946 production amounted to some 136,000 tons, dry-salt basis, while the 1947 exportable surplus is expected to approach 180,000 tons dry-salt basis, which is about in line with immediate pre-war exports.

The following table shows the estimated exportable supply of salt fish:—

Pre-War Compared with 1946-47 and Estimated 1947-48.

	Metric Tons, Dry Salt Basis*		
	Pre-War	1946 Prod'n.	1947 Prod'n.
Newfoundland	52,200	45,300	49,900
Norway	40,800	45,300	54,400
Iceland	31,700	9,100	22,700
Canada	18,100	18,900	20,400
United Kingdom	8,200	1,400	500
France	13,600	—	—
Denmark, Faroe Islands and Greenland	15,200	15,200	24,300
St. Pierre and Miquelon ...	1,400	900	1,400
Sweden	—	—	6,300
Totals	181,200	136,100	179,900

*The following conversion factors are used:—

(a) $1\frac{1}{2}$lbs. of semi-dry fish (43-50 per cent moisture content) equivalent of 1lb. dry salt-basis. (b) $1\frac{3}{4}$ lbs. of wet-salted (over 50 per cent. moisture content) equivalent of 1lb. dry-salt basis.

HERRING

Most of the main herring-producing countries have submitted information on total landings for 1946, the utilisation of these landings and the quantity of end-products.

Fishermen from sixteen reporting countries landed altogether 2.8 million metric tons of herring and herring-like fish, which is about 15 per cent. of the estimated total pre-war world landings of all types of fish, herring included. About one-third of the herring landings in 1946, converted to wet basis edible weight (1.1 million metric tons), were used for human consumption. About the same quantity was used for conversion into oil and meal and possibly 0.1 million tons for bait. The remaining quantity, 0.4 million tons was "waste"; this might include some small quantities used for fertiliser and for animal-feeding stuff other than meal.

The marketed weight of the various herring products in 1946 was:—Fresh and frozen, 290,000 tons; salted, 390,000 tons; dried only, 120,000 tons; canned, 170,000 tons; meal, 130,000 tons; oil 60,000 tons.

According to information available, the 1946 production of herring and herring-like fish was slightly below the immediate pre-war average. Landings by the United States and Norway, which accounted for 40 per cent. of the total, were 21 per cent., and 16 per cent. respectively below pre-war. United Kingdom and French landings showed some decrease from pre-war, but in Belgium, Denmark, Netherlands and, to a lesser extent, Iceland, landings exceeded the pre-war average. At the writing of this report, information was not available on the Japanese landings of herring and herring-like fish.

Argentina

The growing population of this large country, a large part of whom are immigrants or descending from them, are consuming large quantities of fish, considering the warm climate. The sea fisheries in particular enjoy good sales which rose during the war, their catch increasing by approximately one fifth to 42,000 tons. Argentina still imports various kinds of fish, e.g., cod, herring and sardines, mainly from Norway, Great Britain, Iceland, Netherlands, Spain and Portugal, and from the U.S.A.

The local fish canning industry has been steadily growing and now produces about 3,500 tons per year and employs 1,400 workers. The industry is situated in the provinces of Mar del Plata and Buenos Aires.

Curers and other processors have a total annual output of between 55 and 62 million lb. The fish by-products industry is also of growing importance, producing substantial quantities of fish oil and other by-products.

Australia

Since the first world war the fishing industry as a whole has gained greatly in importance and today there are at least 10,000 fishermen actually engaged in fishing operations, while thousands more are employed in curing and canning, and the auxiliary industries. There are a few trawler owning companies on the English pattern, but the bulk of the catch is probably still due to the activities of owner-operators. Only in one fishery, that of mackerel, there are signs of too many operators, but in all other branches expansion is likely to continue. Marketing regulations are in force to ensure a profitable return to the primary fish suppliers. Apart from some varieties of canned fish, there is little export at the moment, but this industry is capable of expanding rapidly.

Belgium

Fish landings at Belgian ports in 1946 totalled 70,000 metric tons. No reliable figures are yet available for the whole of 1947 but the landings were much larger than before the war, and the

total catch for the first seven months of 1947 concerning demersal fish totalled 26,000 tons as compared with 16,700 tons in 1938. Similarly exports of demersal fish, and fresh and salted herrings were far higher than before the war, 16,160 tons being exported during the first half of 1947, as compared with only 4,500 tons in 1938.

Canada

The fishing industry is one of the most important branches of Canadian economic life, and the value of the catch, the production of the canneries, and the exports of fresh, frozen and canned fish, form a substantial income for the Canadian population.

Cod, haddock, pollack, herring and lobsters are the most important varieties on the Atlantic coast, while on the Pacific side, the salmon fishery with a catch of 150 to 200 million lbs. a year is of utmost importance. Together with the United States fishing vessels, the Pacific fishery accounts for 70 per cent of the world's catch of halibut.

During the war, Britain took enormous quantities of Canadian fish, and immediately after the war U.N.R.R.A. used very large quantities for the relief of starving peoples.

The standard of quality control in Canada is very high and the equipment in the curing and canning establishments is up to date and efficient.

Great quantities of cod, haddock, hake, cusk and pollack are dried, and in normal times a large trade in dried fish is done with the West Indies and other southern islands, Brazil and United States, Italy, Portugal, etc. Much fish is also sold in smoked and pickled forms; for example, smoked herring, haddock, salmon, cod, pollack, and alewives and pickled herring and mackerel. Another branch of the Atlantic fishing industry is the production of filleted fish. Fillets are marketed fresh, frozen and smoked.

General prospects of the British Columbia herring season during the 1947/8 season point to fair fishing in major areas depending on the age class of the fish and the time at which the runs occur.

This is the opinion of biologist A. L. Tester and assistant H. C. Stevenson of the Pacific Biological Station. Their comments, which follow, are based on the assumption that herring will be available to the fishermen in proportion to the expected abundance of populations.

Lower East Coast Subdistrict. It is anticipated that the 40,000 ton quota will be reached, although population abundance may be somewhat less than in the previous season. This may cause a lowered availability and a more prolonged season.

Much depends on the abundance of the incoming 1945 year-class (III's) which so far has shown no promise of being especially large.

Discovery Passage (Quathiaski) Subdistrict. The quota of 5,000 tons should be readily filled. The run is supplied by fish which spawn in the northern part of Georgia Strait and, to a lesser extent, those which spawn in the upper East Coast (Alert Bay) subdistrict. Both populations appear to be abundant.

As spawning was relatively heavy in both of these areas in 1947, there should be a good carry-over of large-sized fish. The run, of moderate size as compared with that supplying the main lower East Coast fishing grounds, should provide fair fishing if it can be located during the fishing season.

West Coast Subdistrict. It is anticipated that fishing in this subdistrict will be fairly good, with a probable catch of 30,000 to 40,000 tons.

As in the lower East Coast subdistrict, much will depend on the abundance of the incoming 1945 year class (III's). Though spawning was exceptionally extensive in 1945, this does not necessarily presage an exceptionally large year class.

Present indications are that the 1945 year class will be less abundant than the two preceding year classes which were responsible for the exceptionally large catch of last season. However, if the fish caught at the beginning of the season are generally small, this will indicate a successful 1945 year class and a large run; if they are large, it will indicate a poor 1945 year class and a medium-sized run.

It is expected that the fishery will develop in areas 23, 24 and 25 with area 23 (Barkley Sound) probably the most productive.

Central Subdistrict. Good runs are anticipated in the Laredo area and in the Bella Bella area, particularly the latter. The time at which these runs will appear is unknown.

Northern Subdistrict. There still appears to be a large body of fish in the Northern Subdistrict which for some unknown reason has entered inshore waters after the close of the fishing season during recent years.

If this run appears early excellent fishing should result.

Queen Charlotte Islands Subdistrict. Reports of heavy and extensive spawnings from Dana Passage, Huston Inlet, Burnaby Strait, George Bay, Island Bay, Tangle Cove, Sewell Inlet, etc., were again received.

These runs should provide good fishing if they can be located during the fishing season.

Landings of halibut on Pacific coast of North America during 1947 were approximately as follows:—

Area 1A	...	400,000	pounds
Area 1B	...	150,000	,,
Area 2	...	27,200,000	,,
Area 3	...	28,199,000	,,
Total	...	55,949,000	pounds

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The above weights are net, with heads and viscera removed. The totals are preliminary but will not differ significantly from the final figures.

China

The Department of Fisheries, established by the Chinese Government in 1946 as a branch of the Ministry of Agriculture and Forests, has been taken to develop this industry, and has divided the fishing areas of the country into five provinces or regions, each with its own advisory office. They have also taken over the fishing enterprises established by Japan in China during the war. The Ministry has converted these into three companies equipped with refrigeration, ice-making and deep-sea trawlers. The Chung Hua Marine Products Co., of Shanghai, has eight cold storage and ice-making plants at Nanking and Shanghai, one cod-liver oil factory, one canning factory, and one fishing net factory.

Denmark

Fishing in the first quarter of 1947 was hampered by severe cold, and many Danish waters were frozen over. The catches, therefore, only amounted to about 27 million kg. as against 35 million kg. in the first quarter of 1946. About 9 million kg. of fresh fish and about 6 million kg. of cured fish, mostly salted cod and salted herrings, were exported in the first quarter of this year. The export of salted fish has developed rather strongly after the end of the war, and there seems to be some possibility also in the future of creating a market for these goods, but the export of fresh fish must be considered in the future to be the branch which is most natural for the fishing industry and in this regard the Danish quality goods will be able to hold their own in the foreign markets in the future

A number of trade agreements have been entered into with most European countries, which agreements also include the supply of fish, both fresh and cured Provided that the country can secure the necessary material, particularly fuel and raw material for cordage and implements, and provided that there will still be sufficient markets for the products of the industry, it was anticipated that Denmark would be able to supply the same quantity of fish products in 1948 as in 1947.

The herring fishery on a large scale in the North Sea was started in 1945 with a view to the salting of the catch. This fishing was extended in 1946 and 1947. The fishing methods are not new, as herring fishing with trawl from motor cutters has been practised for a number of years in the Skage Rak and Kattegat, but the fishing area is being extended to include also the middle and northern North Sea.

If it is possible to supply a fully competitive product from these waters, the Danish fishing industry should stand a good

chance of being able to sell its products both on the home market and for export.

Another development within the Danish fishing industry may be mentioned, namely a rather extensive *line fishing of porbeagle* which was started in 1946. This fish may, in a fresh state, be sold at rather fair prices in certain European markets. The porbeagle was formerly landed from the North Sea, but it was then only in more accidental catches, while now a number of vessels are fitted out for the fishing of porbeagle. On account of the promising start, it is intended to continue fishing this variety.

Fish filleting has been steadily increasing since 1937 and is still increasing, both for the supply of the home market and for export, even if the bulk of fresh fish is still sold in its whole state or cleaned and iced.

A large quantity of salt fish, mainly for export has been produced, and there seems to be some possibilities of this production being continued for some time to come.

Freezing of fish was undertaken on a small scale only before the war, but extensions of the existing plants have been made, and some new plants have been erected. Frozen products have hitherto only formed an insignificant part of the Danish fish export and these articles are only sold in this country to a very slight extent.

An increasing amount of work is being performed by the authorities in regard to the control of the quality of the fish. An effective control of the fresh fish for export is undertaken, but also the concerns which cure various kinds of fish are subject to a number of regulations as regards the hygienic arrangements of the premises, and an effective inspection of the production itself is being undertaken.

Exports of fishery products in the first half of 1947 totalled about 67 million krg., against about 71 million krg. and 17 million krg. in the corresponding periods of 1946 and 1938.

Eire

Ireland has 3,472 fishing vessels out fishing, including 3 deep-sea steam trawlers, 568 motor-boats, 758 sailboats and 2,143 oared craft.

Great efforts have been made since 1939 to increase the supply of fish caught by Irish boats based on Eire ports, but these endeavours have been handicapped by lack of modern boats and fishing gear, and trained men. The Irish industry complains of poaching by foreign trawlers in their territorial waters especially on the part of the Spaniards. Recently a new organisation has been established to assist and promote the fishing industry, and to ensure a profitable return to the fishermen. This organisation is called "Muintir na Mara."

Below are shown the quantities of the various kinds of Sea Fish as landed on the coasts of Ireland* during the six months ended 30th June, 1947, and in the corresponding period of 1946.

Kinds of Fish	Quantity 1946 cwt.	Quantity 1947 cwt.
Brill	231	253
Soles	949	818
Turbot	261	232
Total Prime Fish	1,441	1,303
Cod	12,185	12,819
Conger Eel	1,225	576
Haddock	292	606
Hake	1,903	1,517
Herrings	8,422	10,955
Ling	865	805
Mackerel	49,391	19,134
Plaice	7,514	5,819
Ray or Skate	8,074	7,963
Sprats	—	—
Whiting	29,143	23,716
All other except Shell Fish	5,239	7,764
Total Wet Fish	125,694	92,977
Shell Fish	Quantity in Nos.	
Crabs	3,936	4,254
Crayfish	2,917	4,104
Escallops	470,398	329,214
Lobsters	56,741	24,025
Oysters	24,581	13,419
Grand Total of Value	£271,556	£217,960

NOTE.—These figures will be increased somewhat by certain additional information to be collected at close of calendar year.

*Exclusive of the Six North-Eastern Counties.

The Irish Sea Fisheries' Association, Ltd., was set up by the Eire Government in 1930 to help Irish fishermen to provide, out of their own resources, the boats and gear necessary to win a livelihood.

The loan system previously in existence having proved a failure in changed conditions, it became necessary to substitute something for it if Irish fishermen were to be enabled to make a living. Accordingly, the Government decided to set up a co-operative association of fishermen, with State assistance, to provide approved applicants with boats and gear, to be paid for out of the

catches. This was the origin of the Irish Sea Fisheries' Association, Ltd.

Functions of the Association include the development of the sea-fishing industry by the provision of boats, engines and gear for members on hire-purchase terms.

When a member fisherman requires the help of the Association in the purchase of a new boat, he discusses his requirements with officials of the Association, who, having approved his plans, and having approved of the potential purchaser himself, upon payment by the purchaser of 20 per cent of the cost of the boat, place an order for the boat to be built at one of the Association's boat building yards, or with one of the leading Irish shipbuilders.

Repayments are made to the Association in proportion to weekly earnings, and not by fixed amounts.

Some 150 motor fishing vessels of various sizes have been issued on hire-purchase terms, and there were about five times as many smaller transactions involving canoes, curraghs, etc. In addition, there were repairs to hulls and overhauls of engines held by members prior to the advent of the Association. The Association operates several repair shops at various ports in Eire.

From 1st January, 1948, owners of fishing boats in Eire will be required to carry certain life-saving appliances, such as life boats, life buoys and life jackets.

European Fish Supplies

Members of the Study Group of the U.N.O. have submitted statements showing the position of the fisheries in their countries as regards production and consumption. These summaries afforded much valuable material for the F.A.O. European Regional Office. A statistical summary was also prepared from information supplied by the members of the Study Group.

Eire, Belgium, Spain, Sweden and Germany were not represented at the meeting, consequently the statistical table is incomplete. To it must be added the following information obtained from other sources:

Eire:	Estimated quantity of fish available for export in 1948.	7,000 tons
	Estimated quantity of fish required for import in 1948.	250 tons
Belgium:	Estimated quantity of fish available for export in 1948.	48,000 tons
	Estimated quantity of fish required for import in 1948.	68,000 tons
Spain:	Estimated production in 1948.	600,000 tons
	Estimated consumption in 1948. ...	Quantity unknown but likely to be in excess of the production figure.

Sweden: Estimated quantity of fish available for export in 1948.	80,000 tons
Estimated import requirements for 1948.	34,500 tons
Germany: Estimated production in 1948. ...	161,000 tons
Estimated consumption.	221,000 tons

In addition to the above, Newfoundland expects to have 21,000 tons of dried salt codfish available for export to European countries in 1948.

Certain members of the Study Group expressed the opinion that the production of cod fishery would fall in 1948. On the other hand, it was pointed out by other members that herring fishery was not fully exploited by certain countries, and was capable of considerable expansion which would more than offset any reduction in the supplies of cod.

From the discussions on the problems affecting the European fishing industry it became abundantly clear that F.A.O. could not hope, with the facilities at its disposal, effectively to solve all of these problems in the immediate future, and the Study Group therefore came to the conclusion that F.A.O. should, in the first instance, concentrate its energies upon the more immediate and pressing problems which relate principally to distribution and marketing.

The need for further study of the stocks of fish in the sea and the effect of commercial fishing upon these stocks was fully recognized by the Study Group, who were anxious that close liaison should be maintained between F.A.O. and international bodies such as the International Council for the Exploration of the Sea, so that scientific work might be carried out in the most efficient manner and without duplication. In this connection the proposal for the establishment by Convention of Regional Councils for the study of the sea was noted and certain members of the Study Group expressed the hope that the area coming within the jurisdiction of the International Council for the Exploration of the Sea would be satisfactorily settled by agreement between the nations concerned and the Council. The importance of a Fish Regional Council for the Mediterranean Sea and contiguous waters was stressed and certain members felt that a similar Council should be set up for the Black Sea area. It was, however, pointed out that most of the nations in this area were not members of F.A.O. and until they decided to take up membership of that body, they could not take any action in the matter.

The Study Group showed a lively concern regarding the production of fish of the highest quality and the maintenance of this quality throughout the chain of distribution to the consumer. It was felt that there were many deficiencies in the distributive system and because of these, efforts of the producing countries to maintain or raise the quality of their products might be defeated. The importance of quick freezing and the storage and distribution

of frozen fish were fully recognised and the Study Group gave highest priority to the need for obtaining as quickly as possible complete information about the facilities in Europe for handling frozen fish. It was recommended that F.A.O. should make a survey of these facilities and communicate the results to member Governments.

It was pointed out that the technical development of cold storage and up-to-date methods for maintaining a low temperature of frozen fish throughout distribution were of special importance in developing the market for frozen fish in Europe, and it was felt that the recommendations of the F.A.O. Preparatory Commission on World Food Proposals, with particular reference to the provision for financing facilities in connection with warehousing, cold storage and transport for perishable products, would, if adopted, be particularly helpful in the consuming countries and would enable them to set up necessary facilities for handling frozen fish.

The discussion turned on the following points:

(1) the need for improvement in the quality of fish and the maintenance of the highest possible quality standards;

(2) the need for more speedy handling of fish in the production countries;

(3) the need for improved methods of packing fish;

(4) the need for speeding up transport in all kinds of fish and particularly frozen fish, with special attention to the avoidance of transport delays at trans-shipment points en route;

(5) the creation of proper marketing organizations within the consumer countries;

(6) and the stimulation of consumer demands.

Table I.—*Production of Fish* (*)
(Estimated landed weight in 000 metric tons).

Country	1947 Herring	1947 Other	1947 Total	1948 Herring	1948 Other	1948 Total
Denmark ...	30	180	210	30	190	220
France ...	50	300	350	50	300	350
Greece ...	—	35	35	—	40	40
Holland ...	117[1]	86	203	117[1]	94	211
Iceland ...	315	270	585	315	300	615
Italy	—	160	160	—	160	160
Norway ...	750[1]	350	1,100	650[1]	300	950
Poland	9	66	75	12	86	98
Portugal ...	100[1]	155	255	100[1]	155	255
U.K.	255	845	1,100	280	875[1]	1,155
Belgium[2](*) ...	50	54	104	50	60	110[3]

(*) Excludes shell fish.
[1] Includes sprats, sardines and pilchards.
[2] Since Study Group met, data received concerning Fish Production.
[3] Estimated landed weight in 000 metric tons; without sprats, shell-fish and molluscs.

Table II—*Fish Consumption* (*)

(Estimated weight as landed in 000 metric tons).

Country	1947 Herring	1947 Other	1947 Total	1948 Herring	1948 Other	1948 Total	Pop. in 000
Denmark	25	25	50	25	25	50	3,750
France	50	300	350	50	300	350	35,000
Greece	10	55	65	10	55	65	8,000
Holland	44[1]	56	100	42[1]	50	92	10,000
Iceland	10	5	15	10	5	15	145
Italy	—	200	200	—	200	—	46,000
Norway	30[1]	90	120	25[1]	75	100	3,000
Poland	68	54	122	72	80	152	22,000
Portugal	40[1]	185	225	40[1]	185	225	7,500
U.K.[2]	185	1,020	1,205	200	1,100	1,300	46,500
Belgium[3]	35	50	85	35	51	86	—

(*) Includes sprats, sardines, pilchards.

1 Production figures inserted in absence of indication of probable imports.

2 Excludes shell fish.

3 Since Study Group met, data received concerning Fish Consumption.

France

Like in other British and Continental fisheries the French fishermen complain of overfishing, and are very pessimistic on the effects of this abuse. Unfortunately, the Government, pre-occupied with wider issues has done little since the war to prevent a deterioration of this import branch of her food production. Figures relating to the volume of fish supplies will be found in earlier pages containing the survey of European fisheries.

Germany

After some hesitation, the authorities in the British zone have given their support and encouragement to the German fishing industry realising its importance in solving the problem of food supplies in the bi-zonal economy. In order to increase the fish catch of the bi-zonal area, steps are now being taken to make available to the German economy for fishing purposes a portion of the pre-war German fishing fleet used by the German Navy during the war and taken over as reparations by the Tripartite Naval Commission.

When this fishing vessel conversion programme is completed the combined British and U.S. Zones will have a fleet consisting of 209 trawlers, 124 luggers and 2,751 cutters and other small craft operating in the North Sea, Baltic Sea and waters adjacent to Iceland and Bear Island. With fish supplementing the supply of fresh meat in the bi-zonal area and, thereby, increasing the protein content of the German diet, the importance of this programme cannot be overestimated.

The German fishing fleet in 1938 consisted of 375 trawlers 168 luggers and 11,448 cutters and other small craft. Most of these vessels at the outbreak of war were taken over by the German Navy to be used for other-than-fishing purposes. The KFK cutters used by the German Navy were so constructed that they could be converted to fishing vessels in case of a Nazi victory. Many of these vessels were sunk or other-wise incapacitated during the war while others that were still serviceable at war's end were either used by the Allies for minesweeping purposes or were operating in the Baltic Sea or other areas not under UK/US jurisdiction. As the minesweeping activities came to an end, more and more of these vessels became available for conversion but shortages of materials and marine railways have seriously hampered the programme.

The Fisheries Bipartite Control Group, which is composed of 10 Britishers and 3 Americans, supervises not only operations of the fishing fleet but also fish imports, processing and distribution. Prior to the bi-zonal economic merger on January 1, 1947, the total catch, which averaged about 20,000 tons monthly during 1946, was pooled with 55 per cent. going to the British Zone and 45 per cent. to the U.S. Zone. The distribution of the catch since that date has been arranged on the basis of 500 grams of processed fish per ration period for each non-self-supplier in the combined area.

Great Britain

It is doubtful whether in the memory of the present generation there has been greater activity and more rapid development in the fisheries industries than since the end of the last war. Grimsby as the major fishing port leads this movement, the outstanding feature of which is the introduction of quick-freezing plants, and the modernization of curing establishments. There is no doubt that packing and distribution will also undergo a profound change as soon as materials are available. Developments in this connection are beyond the experimental stage, and one can visualise—without stretching the imagination—that the day will come soon when fresh fish caught thousands of miles from the coast will reach the markets inland in perfect and most hygienic conditions.

The fisheries as part of the food industry are, of course, subject to controls and price regulations. These restrictions, and the difficulties in obtaining fishing gear, particularly nets, and packing materials, have interfered with a more rapid extension in fish supplies. The quality of fish landed has deteriorated during the past year, and great losses have been incurred by the industry through the condemnation of fish arrivals as unfit for human consumption. It is clear that processing on board ship is the most thorough solution to this problem, but there are other improvements which can and must be used by trawler owners and others, as a stop gap measure until the time when "factory" ships will be available in sufficient tonnage.

British Imports

FISH (not of British taking)—

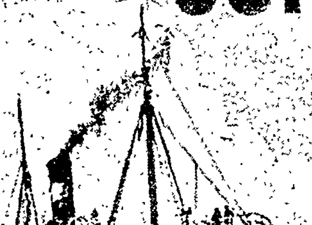
Fresh or frozen—

		1938	1946	1947
From Eire	Cwt.	22,070	65,198	70,658
„ Canada	„	68,928	66,553	26,359
„ Newfoundland ..	„	23,970	65,642	3
„ Other British countries	„	127	5	17
„ Norway	„	227,221	506,028	1,049,798
„ Iceland	„	122,041	293,553	165,561
„ Denmark	„	329,795	350,012	381,363
„ Faröe Islands ..	„		86,450	42,453
„ Netherlands	„	29,088	9,118	14,708
„ Belgium	„	20,329	19,637	134,308
„ Deep Sea Fisheries..	„	371,660	2,586,400	2,378 883
„ Other Foreign Countries	„	420,153	9,314	19,181
Total Herrings	„	*386,989*	*418,732*	*720,101*
Salmon and migratory trout	„	124,869	23,369	40,109
Cod	„	222,223	1,772,189	1,303,700
Haddocks	„	136,923	490,393	320,884
Plaice	„	349,164	749,422	770,573
All other sorts ..	„	415,214	603,805	1,127,925
Total		1,635,382	4,057,910	4,283,292
Wet, salted, split ..	„	259,094	44,334	71,282
Shell fish, fresh, for food ..	„	172,482	80,150	99.321
Fish, cured or salted, not canned	„	108,139	62,769	12.531
Fish, canned—				
Brisling	„	36,471	46,244	67,779
Pilchards	„	59,231	224,158	327.818
Sardines—				
From British Countries ..	„	—	—	31
„ Portugal	„	70,456	232,871	9,858
„ Other Foreign countries	„	36,931	21,909	6,690
Total	,	107,387	254,780	16,579
Salmon—				
From Canada	..	155,679	512,796	207,938
„ other British Countries	„	37	2	—
„ Soviet Union ..	„	300,608	—	25,434
„ United States of America	„	299,373	346,222	433,270
„ Other Foreign Countries	„	396,132	—	90
Total	„	1,151,829	859,120	666,732
Crab	„	75,989	—	11,716
All other sorts—				
From British Countries ..	„	3,288	27,609	152,162
„ Norway	„	37,448	70,871	75,424
„ United States of America	„	13,811	82,593	148,852
„ Other Foreign Countries	„	35,831	5,078	116,371
Total	„	90,378	186,151	492,809

British Catches of all Fish

PRELIMINARY STATEMENT showing TOTAL QUANTITY and VALUE OF SEA FISH of British taking returned as landed in England and Wales during 1947 and 1946, with totals for Great Britain, i.e. including Scotland:—

Kinds of Fish	Quantity		Value	
	1947	1946	1947	1946
Bream	30,373	16,604	37,554	20 841
Brill	5,130	6 634	41,463	72,771
Catfish	78,253	39,140	114 261	57 759
Cod	5,513,380	4,839,043	11,569,745	9,799,600
Conger Eels	43,496	38,886	69,491	61,592
Dabs	93,137	34,687	280,395	112,002
Dogfish	137,247	110,887	162,538	136,505
Gurnards and Latchets	45,933	32,431	42,091	30,864
Haddock	1,717,473	1,594,164	4,398,224	4,044,492
Hake	802,451	1,238,447	2,482,949	3,294,978
Halibut	44,577	28,477	340,315	203,797
Lemon Soles	12,262	13,957	59,217	66,673
Ling	147,381	134,132	252,132	246,267
Megrims	31,296	26,694	95,268	89,469
Monks or Anglers	20,133	18,783	47,284	46,024
Plaice	860,548	1,065,677	4,182,041	5,128,069
Pollack	10,643	3,934	19,315	7,170
Redfish	118,276	37,397	167,271	54,784
Saithe (Coalfish)	513,468	255,194	692,653	339,166
Skates and Rays	293,912	227,830	563,596	428,111
Soles	86,063	94,049	759,126	790,850
Torsk	3,042	1,692	5,156	2,959
Turbot	86,057	76,807	691,284	577,641
Whiting	267,936	222,113	485,003	403,621
Witches	12,181	5,187	38,012	17,650
Livers of Fish	464,349	439,416	369,849	295,926
Roes of Fish	38,224	19,477	116,936	60,453
Other Kinds or Mixed	167,784	137,701	495,380	314,315
Total Demersal	11,652,597	10,768,380	28,605,441	26,738,144
Herrings	2,113,500	1,799,134	2,236,761	1,802,430
Mackerel	23,431	15,528	43,397	20,160
Pilchards	62,112	51,690	73,197	52,222
Sprats	37,502	21,735	38,070	21,991
Total Pelagic	2,238,638	1,888,087	2,392,458	1,896,803
Total Wet Fish	13,892,658	12,657,758	31,003,041	28,639,292
Total Value Shellfish	—	—	850,340	927,653
Total Value of all Fish	—	—	31,853,381	29,566,945
Great Britain Demersal	15,287,878	13,858,501	36,636,690	33,852,064
Great Britain Pelagic	4,584,910	4,147,219	4,868,844	4,348,611



The catch of demersal and pelagic fish during 1947 was slightly better than during the previous year, in England and Wales as well as in Scotland. Full details will be found in the statistical tables on pages 30 and 31.

Exports of curred herrings were also better than last year, and the same applies to canned fish. Details of this trade and of fish imports are printed on the following pages.

Iceland

The development of modern fisheries and a fish processing industry started just before the first World War and has since proceeded at a rapid rate with the result that this small island so far away from any continent, is one of the most important exporters of fish and fish products. The Federation of Fishing Vessel Owners are mainly responsible for the processing and marketing of salted fish while herrings are handled by a state corporation. All other products are privately dealt with though there are regulations governing export prices.

The following tables will give a good idea as to the volume of Icelandic exports of fish and fish products:—

Exports in 1946

Salt fish	11,500	tons
Frozen fish	73,000	,,
Frozen fillets	24,000	,,
Fish conserves	500	,,
Fish meal	6,200	,,
Salt roes	1,500	,,
Medicinal oil	7,745	,,
Herring oil	17,500	,,
Herring meal	10,200	,,
Salt herrings in barrels	160,000	barls.

The following were Iceland's main customers for the above commodities, their purchases in million Kroner amounting to the following sums:—

Great Britain	106
U.S.S.R.	58
U.S.A.	38
Denmark	30
Sweden	15
Greece	10
Czechoslovakia	8.5
France	9
Italy	6.5
Netherlands	2.8
Norway	1.8

The detailed figures, quantities only, for the first nine months of 1947 are as follows:—

Exports of :—	Jan./Sept. 1947
Salt Fish	15,920 tons
Fresh Fish (on ice and frozen)	56,402 ,,
Canned Fish	134 ,,
Herring Oil	16,400 ,,
Herring and Fishmeal ...	12,000 ,,
Roes Salted	10,463 barrels
Herring cured	25,375 ,,

At the end of the year an agreement was reached between the authorities in Iceland and those of the Anglo-American zones in Germany for the purchase by the Anglo-American authorities of up to 70,000 tons of Icelandic fish for consumption in the combined zones of Germany during 1948.

Arrangements have been made for the immediate shipment of fresh herring from Iceland to Germany.

There are now over fifty steam trawlers and 650 cutters active in Iceland. The processing plants are large and modern and the filleting capacity amounts to 750 tons. The Government has a majority holding in the herring oil factories which have a capacity of 110,000 hectolitres per year.

The rich resources of the fishing grounds near Iceland and the industry and efficiency of the population guarantee a promising future for its fisheries.

India

In the "new" India, efforts are being made to develop the fishing industry in every way.

The Government of Bombay has devised a number of plans for the improvement of the fishing industry. The Government has been experimenting in improved construction of fishing vessels, calculated to increase their range and improve their storage capacity. Two deckless vessels, 45-footers, with arrangements for fish storage, are under construction. Thirty such vessels are to be built in the next five years and are to be made available at as many fishing centres as possible on a subsidy-with-loan basis. The Central Government and the Government of Bombay, sharing expenses equally, have also financed experimentation with a 52-foot vessel manned entirely by members of the fishing community and equipped with a 160 horsepower engine. A second trawler has been ordered from England for the use of the deep-sea fishing plan which was inaugurated some time ago in Bombay.

Additional cold-storage facilities are to be built in Bombay and two large fishing centres along the coast are to be erected. A considerable sum has been appropriated for the improvement of fish curing along the coast.

Training in the fishing industry is to be promoted by the establishment of a fish farm at Khopoli, where apprentices from

the fishing community are to receive Government training. A grant has been given for the training of two science graduates, who are to be sent abroad for training in technological problems connected with fishing. The Bombay Government will also submit the names of four candidates to the Central Government which plans to send youths to Grimsby for training.

A Central Fisheries Research Institute, with four main stations at Bombay, Mandapam and Karachi and one in Bengal, is now under examination by the Government of India. As a preliminary to the establishment of the Central Research Institute, an interim fishery scheme has already been approved at an estimated cost of Rs. 2.37 million. In connection with a deep sea experimental pilot fishing unit a trawler is being remodelled at Bombay and a fishing trawler is on its way from England. An interim marine fisheries research scheme has also been started at Madras, and plans are well in hand for work at Mandapam in Madras and Pulta near Calcutta in Bengal.

Fisheries which are exploited in India are those of the Inland and coastal waters in a zone not extending much beyond the 5 miles limit, while the rich off-shore and deep-sea fisheries along India's extensive coastline, are hardly touched for want of essential information about the fisheries, and the absence of power crafts and gear. The purpose of the proposed research scheme will be to explore these waters both with reference to the fishing grounds, and most productive period or periods.

In addition to the 4 main stations proposed, a chain of subsidiary stations is considered necessary all along the extensive coastline. It is hoped that these will be established by the maritime Provinces and States as part of their fishery development schemes.

It is necessary to increase fish production considerably in India if people are to have an adequate supply of this essential food.

Japan

Not many people know that before 1940 Japan was the leading fishing nation if quantity of production is taken as a criterion. Much study, research and efforts have been devoted to bringing the Japanese fishing industry to that state. Naturally, as a result of Japan's mad venture into the last war, she has lost that position and many of her resources which made the great development of her fisheries possible.

Dr. Neal Carter, director, Pacific Fisheries Experimental Station, Vancouver, after a six months survey of the Japanese fishing industry, presented a report on the position in Japan.

The Japanese lost, as a result of the war, their former Northern salmon and crab fishing grounds around Karafuto and the Kuril Islands, also the use of shore canneries on the

Kamchatka Peninsula. This has greatly curtailed the salmon and crab fisheries. Those that remain are confined principally to Hokkaido, the northern main island of Japan proper. Dr. Carter made a visit to two salmon and crab canneries on the north-east coast of this island, also to a can-manufacturing plant. Some fish canneries on the main island of Japan were also visited.

As to the future of Japanese fishing in Russian and International waters, no real policy had yet been evolved and probably would not be until after the peace treaty for Japan.

Mother Ships and Floating Processing Plants

Only one floating processing plant remained unsunk at the end of the war and this was not allowed to be used, nor is there likelihood of such ships being allowed to go far from Japanese home waters for some time in the future. An exception was the Japanese Antarctic Whaling Expedition which left Tokyo, November, 1946 after careful SCAP ("Supreme Commander for the Allied Powers") considerations and after some criticism by other Allied countries. This expedition was well justified; the purpose of the expedition was to provide flesh and fats for strictly Japanese food uses. In going over one of the two factory ships he found merely a hastily-reconverted oil tanker, not a pre-war processing vessel.

His inspection of the manufacture of cotton and linen Japanese fishing nets is on file at Ottawa, the Vancouver Station, and the B.C. Research Council. A type of knotless mesh for gill nets and larger nets was seen, and particulars of these supplied. Their work on fish net preservatives is behind the work on this continent. Not a great deal of information on the anti-fouling of nets and other materials subjected to sea water was securable; that which was secured indicated that the Japanese were far behind America in such work. The factory visited was the Hirata Fish Net Manufacturing Factory, Yokkaichi.

Refrigeration Plants and Processes

This was a subject which the U.S. Fisheries Division in Tokyo asked him to study especially. Numerous field trips were made for this purpose and representative plants in damaged and undamaged localities were critically examined. The plants were fairly modern, but poorly managed; nothing in the way of freezing and storage procedures was seen that is not already known on this continent. Reports are on file relative to freezing and cold storage operations in Tokyo, Osaka, Yaizu, Aomori, in Hokkaido, and other areas.

Fishing Craft and Gear

Descriptions of engine-propelled Japanese fishing craft have been available since before the war and no significant changes in type occurred during the war, hand-propelled (and some engine-propelled) fishing craft are of types that would not be desired on

our coasts. A demonstration of up-to-date trawling and seining procedures was witnessed during a special trip on the Japanese Imperial Bureau of Fisheries' training vessel "Syunkoto Maru." The procedures were practically identical with those used in our waters. The common double-keeled fishing vessels (up to 50 feet long) with propeller in a tunnel, remain upright when beached daily, and the propeller needs no net guard.

Organization of the Japanese Fishing Industry

This turned out to be an extremely complicated subject, and one to which a great deal of attention had been paid by the U.S. authorities. Reports have been made on production of the fishing industry of Hokkaido and the organization of the industry in the northern part of Japan. Also of the associations in their fishing industries, and of fish marketing. The Japanese fishing industry organization is complex, including all phases of production and processing of sea foods, as well as that of vitamin oil and fish oil and meal. The large monopolistic concerns engaged in fishery exploitation in Japan have been broken down by SCAP directives.

Japanese fisheries research was reviewed during numerous observations made in the course of field trips and visits to universities and fisheries research institutions, among which were the Okayama Medical College Department of Biochemistry, Marine products research institutions at Hamajima, Yoichi, Hakodate, Tokyo and elsewhere. Most of these institutions were greatly understaffed and in some cases hardly operating.

Generally speaking, a search through available records reveal little scientific data not known to, or surpassed by Canadian and American fishery-marine research scientific organizations.

Reparations

There is no likelihood of any fishing vessels, canneries or other fish processing machinery being made available for reparations. New fishing vessels were being built, and encouragement was being given to use all existing equipment for catching and processing of as much fish as possible for Japan's own home needs for food. With regard to the possible utilization of Japan's patents on fishery products, the United States authorities had not yet formulated a policy.

Morocco

The Atlantic coast of Morocco borders on fishing grounds which are considered practically inexhaustible. Among the different varieties of fish, the sardine occupies first place. There are three principal zones of the sardine fishery; in the North, Fedala and Casablanca; in the centre Safi and in the south Agadir. Safi is one of the most important sardine ports of the French Empire with a fishing fleet of 62 boats. The entire Moroccan fishing fleet now totals 5,000 tons owned by a

number of firms which employ 5,500 fishermen. The fishing fleet comprises 25 chalutiers, 155 sardine cutters, 85 motor vessels and 900 small barges.

A fishery school for Muslims will soon be opened in Safi to train more as fishermen. Safi is responsible for about half of the total fish catch and for 80% of the sardine catch of Morocco.

The development of Moroccan fisheries can be judged by the fact that since 1922 when the catch totalled only 2,200 tons, the quantities landed rose to 30,295 tons in 1938 and increased still further to 50,900 tons in 1946. Out of this total 30,964 tons were sardines.

The canning and curing of fish absorbed 40,672 tons while the remainder was consumed locally in the fresh state or made into by-products.

The Moroccan canneries and curing establishments of which there are about fifty produce canned, smoked and salted fish, the quantity amounting annually to about 20,000 tons during 1946 of canned fish, 20,000 of salted and 1,500 tons of smoked fish. Some of the factories are also making fish by-products. Agadir is the most important centre of the fish processing industry in Morocco.

Netherlands

Fifty years ago the first steam trawlers were introduced into the Dutch fishing industry but Holland is probably the oldest important export fishing country in the world. At least 500 years ago the Dutch were exporting salt herrings to all parts of North and Western Europe. There have been booms and gluts in the fish trade of the Netherlands but today it is once again of utmost importance in the world's fish supply. The herring fishery is proportionately of greater value than in the other leading fisheries of the world, which is borne out by the value of the entire Netherlands catch in 1938. In that year the catch of the herring drift net fishery was valued at 72 million florins, while the value of fish landed by trawlers was slightly less than seven million florins.

The trawl fishery comprised about 1,200 vessels soon after the first world war, their catch varying between 35 and 50 million kilos. During the depression years the landings dropped as low as 23 million kilos owing to the restricted export possibilities.

The herring fishery extends from the middle of May to the end of the year, the production being about 20 million kilos of fresh herrings and one million barrels of salt herrings.

In 1946 nearly 20 million kilos of salt herrings were exported compared with an average of 75 million kilos in 1937/38.

During the first ten months of 1947 exports of salt herrings increased to 38 million kilos compared with only 25 million kilos in the corresponding period of 1939. The value of the 1947 exports totalled 15,727,000 florins. Nearly half of the quantity,

namely 15 million kilos for 6 million florins, were sent to the U.S.S.R., with Germany and Belgium as the only other markets of importance. Small quantities averaging from 200 to 400 tons each were exported during these nine months to Argentina, U.S.A., Palestine, Sweden, Czechoslovakia and Finland.

Exports of fresh fish were not so important, but considerable quantities of fish and crustaceas are being canned by large and small canneries in the Netherlands and exported as such.

The Netherlands fish preserving industry is being forced to look to the export field. During the war, the industry expanded because competition from foreign sources was restricted and the domestic demand was high. At present the production capacity is too large for the domestic market. The industry is now able to export such items as herring in oil, herring in tomato sauce, fried herring, various mackerel products, smoked and stewed eel, chopped fish and fish paste. The fish preserving industry came into being a few years before the war, and there are now 43 plants, of which 15 are mussel packing and processing factories.

Newfoundland

Cod fishery is the most important branch of industry in this island which forms one of the British Dominions. Much progress has been made in the Newfoundland fishery industry during the war and since, though 1947 has been a difficult year owing to the transition from war to peace-time transactions.

Final returns covering the cod fishery are not yet available, but reliable estimates indicate that the total catch of all types in 1947 will exceed 1,000,000 quintals (of 112lbs.), as against 900,000 quintals for 1946.

Salted Codfish

Throughout the history of this Island salted codfish has continued to be the major export in so far as the fisheries are concerned. This product is derived from three main sources of fishing, i.e., inshore, deep sea and Labrador (of which the inshore fishery accounts for about two-thirds of the total catch). Exports during the calendar year 1946 amounted to 1,115,066 quintals (cwts.), the highest since 1940, and it is expected that final figures for 1947 will show a further slight increase.

The principal markets for salted codfish, as in the past, are Portugal, Spain, Italy, Brazil, Porto Rico and the British West Indies. Prices in these markets are thus far being maintained.

From 1943 up to and including the 1946 production, contracts for sale were concluded in conformity with allocations fixed by the Combined Food Board and the International Emergency Food Council, at scheduled export prices, between local marketing groups and the various Government bodies and buyers concerned. In the case of the 1947 production, however, international restrictions were lifted and trade with consumer countries was resumed

along very nearly normal lines. In the Newfoundland marketing set up there was one noteworthy change during 1947. This was the merging of all salted codfish marketing groups into one association, known as the Newfoundland Associated Fish Exporters Limited. In brief, this is an Association of licensed exporters of salted codfish, and it is only through the Association that sales for export and exports of this product can be made.

Frozen Codfish

During 1946 there were 45 filleting and 19 quick freezing plants in operation in Newfoundland, and it is worthy of note that operators of these plants are keeping well abreast of the latest and most modern methods of production, freezing and packaging of the frozen products. The recent introduction of draggers, of a most modern type, as catching units is a further step forward in the prosecution of this branch of the fishery.

That the frozen codfish industry has made great strides during recent years can be gathered from statistics which record the exports of frozen and chilled codfillets and round cod in 1940 as only 6,542,000 pounds, to a peak figure of over 35,000,000 pounds during 1945. It is recognized that a considerable part of this increase was due to the extraordinary wartime demand in the United Kingdom market, and during 1947 production will be subsequently reduced in view of the loss of contracts with the United Kingdom. Furthermore there has been some falling off in prices in the U.S.A., however, it is hoped to build up the latter market.

It is interesting also to note that, in the case of frozen fish, efforts are being concentrated in locating and exploiting other species, such as haddock and rose fish, in an attempt to diversify the product, and that these investigations are meeting with favourable results. In order to carry out necessary investigations in this respect the Newfoundland Government has suitably equipped a vessel, and under the direction of the Government Fisheries Research Laboratory such investigations are proving of invaluable assistance to all operators of frozen fish plants.

Herring

During recent years the Newfoundland herring fishery has grown to comparatively large dimensions, due principally to the exceptionally great demand for pickled herring by the United Nations Relief and Rehabilitation Administration. This demand has not only resulted in maximum prosecution of this fishery but has also greatly increased the earning power of fishermen. For example, during 1940 Newfoundland's exports of all types of pickled herring totalled only 10,262,000 pounds. By 1946 this figure has climbed to an all time height of very nearly 65,000,000 pounds. The year 1947, however, will record a considerable reduction, due principally to the cessation of U.N.R.R.A. activities.

Salmon

For several years prior to the war, Newfoundland's exports of fresh and frozen salmon averaged between 3,000,000 and 4,000,000 pounds annually, the principal outlet for this product being the United Kingdom. During the war years, however, the frozen salmon output suffered a severe set-back when it was listed by the United Kingdom authorities as a luxury item. Exports during 1946 totalled in the vicinity of 2,000,000 pounds. It is expected that exports will be approximately the same in 1947.

Canned and pickled salmon, which once formed the major portion of Newfoundland's salmon exports, now accounts for but a relatively small proportion of the production.

Lobster

Exports of live lobsters during 1947 will record an all time high, or approximately 3,100,000 pounds, with practically the entire production having been exported, as usual, to the United States and Canada. A recent innovation in the export of live lobsters has been the delivery of several shipments, from Newfoundland direct to the U.S.A., by air freight.

Up to a decade ago the export of live lobsters was well under 1,000,000 pounds annually, with by far the greater portion of the catch being canned. In recent years, however, canned lobster accounts for but a very small proportion of the total production.

Other Types

A variety of other types of fish abound in Newfoundland's territorial waters such as mackerel, turbot, smelts, caplin, clams and scallops, etc., and the quantities landed result in monetary returns to no little degree.

Fish Oils

In addition to whale and seal oils Newfoundland also produces large quantities of codfish liver oils, processed into three separate grades, i.e., common, poultry feed, and refined or medicinal. The total output of codfish liver oils during 1946 amounted to approximately 900,000 gallons, and it was expected that this figure would not show any decrease during 1947. Herring oil as well as other fish oils are also produced, but to a comparatively minor extent.

Norway

The entire Norwegian economic structure could not have developed without its fishing industry, the core of which is the cod fishery. Already in the Middle Ages Norway was the leading country in the production of dried cod, and employed by the Hanseatic League merchants to supply them and through them people in distant countries with this nutritious and well keeping food. Since then the Norwegian fishermen and their counterpart on the land, the processing plants, have made astonishing progress in utilising the resources of the sea in the vicinity of the

Lofoten chain of islands. In this area, the cod population spends the spawning period until about the beginning of April. Then the cod ventures out into the colder parts of the ocean, i.e., the Atlantic and the Arctic. Since the beginning of the century the cod fishery of the Lofoten is regulated by Norwegian laws which provide a kind of Government for the fishing colony during the season which lasts about three months. Anything up to 20,000 fishermen in more than 5,000 vessels—mostly small engine-driven boats—are taking part in this drive and fishery protection boats accompany the fleet. The annual cod catch is roughly 200,000 tons.

As elsewhere, the advent of quick freezing methods have brought about a new era in the development of the Norwegian cod fishing industry and the Government is giving every support to efforts aiming at finding new markets for cod in various forms of processing. Recently, plans have been worked out to enrol air transport in order to bring fish to the consumer markets within 48 hours after catching the cod.

The herring fishery in Southern Norway lasts from January to April, and its catch reaches 500,000 tons during the season.

Altogether 40,000 men are employed in the Norwegian industry directly dependent on fishing.

With very few exceptions, the fishermen are members of a co-operative association which is known as the Norwegian Association for the Sale of Raw Fish, while the processors are similarly organised in associations of their own. Prices and sale conditions are fixed beforehand, and the average earnings of individual efficient fishermen are approximately the same.

Most of the cod is made into split salted cod, stock fish or air-dried cod. When processed as split salted cod, it is delivered to vessels of the buyers on the evening of landing and immediately split, washed and salted in bulk. The roe is sorted, the finest being carefully handled and shipped at once to the canning factories. The greater proportion is salted and packed in barrels, as it is mainly used as bait for the pilchard fisheries. The liver is delivered to the fish factories, where cod liver oil for medicinal and industrial purposes is produced.

The major part of the fleet is not motorised, only 15,000 vessels are mechanically driven. Fifty per cent. of these fishing craft are 30 feet in length, forty per cent. between 30 and 50 feet, and ten per cent. more than 50 feet long. The deep sea craft, numbering some 300, are 80 to 140 feet in length and which are either steam or motor propelled.

Since the war the Norwegian shipyards are installing the vessels with bigger and more powerful motors. The fishery is operated by means of long lines, seine nets and other kinds of nets.

In quantity herrings are still the most important section. In 1938 no less than 620,000 tons were landed, out of a total of

1,065,000 tons for all fish. Other catches were: Cod, 270,744 tons, Saithe, 36,375 tons, Sprats, 6,360 tons, Mackerel, 6,767 tons, Haddocks, 18,841 tons and Norwegian Cod, 10,227 tons.

Norway's exports of fishery products consisted of fresh, frozen, salted, dried and conserved fish; also included in these exports are fish oil and fish meal. There are 175 conserving factories, 60 fish oil and fish meal factories, 20 fish meal factories, 749 liver oil factories, 100 factories for drying fish, 1,400 factories for salting of fish, 1,100 factories for smoking of fish, 800 freezing plants, 100 cold stores, etc., etc.

The exports of herrings in 1939 were: 122,000 tons of fresh and frozen herrings, 48,500 tons salt herrings, 23,000 tons conserved herrings, 67,000 tons of herring meal, and and 120,000 tons of herring oil. Of cod and other kinds of fish the exports were: 32,500 tons of fresh and frozen fish, 22,000 tons dried but not salted fish (stockfish), 33,700 tons dried and salted fish (klipfish), 3,500 tons conserved fish; and in the form of by-products: 14,000 tons of fish meal, 6,000 tons fish roes, and 300,000 tons of fish oil.

In 1946, the first normal post-war year, 900,000 tons of fish were landed at Norwegian ports, whereas 1947 brought still greater quantities.

Exports of Herring

Exports of herring in 1947 are estimated to include about 230,000 brls. of salted "spring" herrings; 450,000 brls. of large herrings; 110,000 tons of fresh herrings; 1,950 tons of smoked and 150,000 brls. of Iceland herring. Exports of other fish: split cod, 45,000 tons; fresh roe, 1,250 tons; fresh salmon, 115 tons. In addition a large quantity of shellfish and canned fish products were sold and shipped to customers overseas.

Generally speaking exports last year improved in every respect. Thus sales to consumers abroad showed the following percentage increases in 1947 as compared with 1946: Herring, fresh—60%; other fresh fish—80%; canned and smoked fish—30%. In fact, the only variety of fish not benefiting by this improvement was salt herring, exports of which showed a reduction of about twenty per cent.

Palestine

Prior to the development of the Jewish-owned and manned fishing fleet during and since the last war, fishing was largely in the hands of Arabs and Italians. Fish was imported from Turkey, while cured and canned fish came from Western Europe and the U.S.A.

Food supply conditions during the war forced the Jewish organisation responsible for the major part of food production, i.e., the Labour Organisation "Histadruth"—comparable to the C.W.S. in the U.K.—to develop the fishing industry on the shores of the sea and Lake Genezareth. As a result there are now

ten trawlers operating and fish landings and processing are increasing steadily.

Palestine is and will remain a good market for the sale of cured and canned fish of every description, particularly herrings and salmon, but excluding shellfish.

In spite of the warm climate, the people of Palestine, particularly the Jewish population, consume a large amount of salted, smoked and cured fish. Salt fish is eaten once or twice a day all the year round, though the main season is from October to May.

The figures below show Palestine's import of fish for the period from January 1st, 1946 to June 30th, 1947. No later official figures are available but it is known that consignments which have recently arrived in Palestine are larger than those imported during the same period of 1946. This is due to the rumour that no Import licences will be issued in future for countries other than the Sterling Block. The consumption in 1947 is estimated to be 5 to 10% higher than that of 1946.

	1946	Jan./June 1947
	In Tons	
Fish in cans	1675 ...	1505
,, dry, salted and smoked	2593 ...	1452
,, in brine	3373 ...	954
,, fresh or frozen ...	1076 ...	524

Canned fish: Of imports into Palestine during the first half of 1947 812 tons came from Norway, 289 from Portugal, 210 from the United Kingdom and 87 from Canada. Prices dropped recently by 5% (in spite of the rise of other food stuffs) owing to the large imports mentioned above, and even with no further arrivals there is at present a stock large enough to last three months. Recently the Government has not isued Import Licences for sardines from Portugal and salmon from Canada, although their prices are lower than those of other countries. On the other hand, licences for tinned fish from Morocco and Norway are granted for, besides being expensive, these countries only offer varieties which are not in demand on the Palestine market, such as kippers.

Salted, smoked and fish in brine: Palestine's quota for 1946 was 60 tons of salted haddock, but owing to the ample supply of other types of fish reaching the country, only 10 tons were imported. Out of the 1,452 tons of salted and dry fish imported in the first half of 1947, Arabia delivered 1,057 tons, Aden 210, Holland 61, Norway 56, U.K. 53. Fish in brine: U.K. 638 tons, Holland 217, Turkey 42. Smoked fish came mainly from the United Kingdom, but local factories also smoke English and Norwegian fish. Fat Matjes herring from Scotland fetch better prices than the common herring. There is no probability of the import of salt fish from Turkish exporters because they demand payment in dollars. The demand for "Lakerda" prevailed only

during the War, when no herrings were available, and no more of these Turkish fish were likely to be imported.

Fresh and frozen fish: In the above-mentioned period 238 tons of fresh fish came from Turkey. Of frozen fish 227 tons were sent from Norway and 51 from Denmark.

Philippines

The Philippine fishing industry, under the direction of the Bureau of Fisheries, has already made remarkable recovery. The pre-war supply came from commercial in-shore fishing, off-shore fishing (which was almost wholly a Jananese monopoly) and pond fish culture in both fresh- and salt-water ponds. During the war the Filipino fishing fleet was virtually wiped out, and great damage was done to the ponds. Already, since the war, $5,000,000 has been invested in fishing vessels. These now exceed the pre-war fleet in number. Moreover, the industry is now owned entirely by Filipinos, whereas before the war is was partly controlled by the Japanese.

The Bureau's programme, when completed, will provide adequate supplies for domestic consumption without the necessity for imports, except for some specialities. Eventually the Philippines may become exporters of fish and fish products.

Fish canning plants will be established and are partly built already.

Poland

The rehabilitation of the Polish fisheries has progressed quicker than that of most other branches of its industrial life, and a thorough organisation has shown good results. By the end of 1946 the fishing fleet comprised 120 cutters and 1,030 other fishing boats, and ship construction was expected to produce a large increase of this fleet during 1947. The number of fishermen employed is now approximately 3,000. The total catch in 1946 amounted to 22,000 tons.

At the end of that year the Polish fish processing industry comprised 85 establishments with actual production of 225 tons of canned fish, 5,000 tons of salted fish and 5,600 tons of smoked fish. It is interesting to note that a considerable quantity of frozen salmon was exported to England and to other countries.

Portugal

Since 1938 the fishing industry has increased its activities and the number of fishing vessels and total tonnage today are considerably larger than before the war. There are now roughly 13,000 fishing vessels with a total tonnage of 86,500 tons as compared with only 11,552 vessels and 68,491 tons in 1938. The number of registered fishermen has, however, steadily declined, and now 31,947 adults and 3,266 minors are employed in the industry, as against 40,676 adults (minors were not registered then) in 1938.

Portugal is, of course, famous for sardines, and these consti-

tute the bulk of the total catch, which amounted to the following quantities during 1946, to which the 1938 figures are added for comparison:—

	1938	1946
	In 000 Tons	
Sardines	113,1	107,5
Cod, fresh	15,4	31,2
Sticklebacks	21,7	38,5
Hake	10,0	9,0
Gilt-head and Bream ...	9,5	10,2
Tunny	1,0	3,9
Others	25,4	31,9
Total	196,1	232,2

The canning industry during the past seven years, had to contend with great difficulties in the supply of tin-plate and olive oil, and, therefore, it is not surprising that production and export of sardines are smaller to-day than in normal years:—

The following table gives the production and exports of sardines and anchovies during the last seven years:—

Production—Quantities in Kilos

	In Olive Oil and Sauces	
Year	Sardines	Anchovies
1940 ...	44,189,136 ...	2,225,356
1941 ...	31,932,787 ...	2,230,733
1942 ...	25,237,092 ...	921,443
1943 ...	36,925,455 ...	2,004,766
1944 ...	33,658,063 .	1,752,199
1945 ...	30,204,756 ...	5,080,125
1946 ...	28,150,457 ...	5,330,640

Export—Quantities in Kilos

Year	Sardines	Anchovies
1940 ...	36,611,340 ..	1,440,008
1941 ...	49,812,644 ..	1,412,199
1942 ...	33,069,262 ...	872,928
1943	37,730,719 ...	1,332,998
1944 ...	33,901,579 ...	1,301,060
1945 ..	28,727,645 ...	3,482,217
1946 ...	33,316,571 ...	3,297,561

From 1941 to 1945 inclusive, tinplate was supplied to the industry by means of collective contracts with the countries buying Portuguese canned fish. From 1946 the Portuguese canned fish industry has been supplied exclusively from the United States, which country established a quota system for Portugal. This quota does not suffice for more than a third of the total requirements.

In respect of olive oil, last year's crop was very poor and this

brought serious difficulties to the manufacturers of packings in olive oil. This year, however, the crop is sufficient to guarantee the normal requirements of the industry. The quantities of mendobi oil supplied to the industry, although limited, have enabled production to be maintained.

South Africa

The major variety of the commercial fishery in the Union is the crawfish (cape lobster) which is exported as canned fish to Great Britain and other countries. This export trade has been limited in order to conserve the crawfish beds.

South Africa's under-developed fishing resources received further attention during the year. Steady progress has been made with the assistance of the Government-owned Fisheries' Development Corporation of South Africa Ltd., which was set up in October, 1944. The Corporation's scheme for financing fishing boats under specified conditions was continued, and special harbour surveys have been completed with a view to the establishment of suitable fishing docks, etc., where no such facilities now exist or where they are inadequate. A Fisheries' Research Institute has been set up in collaboration with the Council for Scientific and Industrial Research, of which control by the industry on a financial sharing basis has been arranged. More extensive surveys of the South African waters are to be carried out, and a new survey vessel with the most up-to-date equipment available is being ordered.

In particular, pilchard fishing as a source of oil and meal, has received special attention and a new company with an authorised capital of £200,000 has been created, in which existing commercial firms have participated. The plant to be set up will treat two hundred and fifty tons of pilchards a day and in addition, quick freezing equipment, now on order, will make available for human consumption part of the pilchard catch. It was hoped that this new equipment would be in operation at the end of 1947.

Four trawling companies operate in South Africa, with 26 steam trawlers and 16 motor trawlers. Approximately twenty other companies operate in crawfish, line fishing and the production of fish oils and fish meals, with approximately 540 line boats.

The fishing industry in South West Africa is also expanding rapidly.

The fish canning factories at Luderitz and Walvis Bay are working full time and supplies of fish are satisfactory. Important development plans are expected to mature in the near future with the concentration of two canning plants at Luderitz in one factory and the conversion of the other into a modern refrigeration unit. A new factory is to be erected at Walvis Bay, and as a result of these enterprises the output of fishmeal and other by-products will be considerably augmented. Additions will also be made to the fishing fleet and other accessory undertakings.

Spain

Spanish fisheries are gradually increasing their activities and fish consumption of the population is increasing slowly amounting now to about 8 kilos per head per year. The Spanish fishing fleet has increased considerably during recent years and now numbers 46,000 vessels of a total tonnage of 202,000 tons. The value of the total catch last year was around 175 million Pesetas. The fisheries and fish processing industries employ approximately 193,000 men and 45,000 women.

The annual catch has increased from 433,000 tons in 1940 to 592,000 tons in 1946.

Spain had a smaller sardine pack because of a lack of olive oil for fish packing, together with higher prices offered for fish in the domestic market, also; the shortage of tinplate. The fishing industry has also been handicapped by disagreements between the packers and the syndicate on fish price fixation and fresh fish distribution priorities. The sardine pack varies greatly, e.g., in 1937 it was 42,000 tons while in 1946 it dropped to 4,800 tons.

Sweden

The Swedish fishing industry is well developed, modern and progressive, and the country's large fish consumption is mainly covered by catches by the Swedish fishing fleet. Exports have not been very substantial since the end of the war but nevertheless Swedish exporters are hoping to extend their sales abroad during 1948. Among the international trade agreements recently concluded is one by which Sweden is to export 500,000 kg. of fillets of cod and whole cod to Czechoslovakia. Large 15-ton Danish motor-lorries have been hired for the transport of the fish, with tanks holding 175 gallons of petrol, enough for the journey to Prague and back. This lorry convoy will travel from Helsingborg via Helsingor, Munster, Hamburg, Hanover, Nuremberg and Plzen to Prague.

Tunis

Tunny is the most important catch of the Tunis fishery. The main centre is at Sidi-Daoud (Cape Bon) while the so-called "small" tunny is fished by boats centred on Gabes. Other fishing centres are Sousse and Mahdia. The canning and processing factories are at Tunis, Sousse, Madhia and Gabes. Their production included last year: Tunny 215 tons; sardines and mackerel 420 tons; salt fish 700 tons.

United States

With Japan out of competition, and particulars for the U.S.S.R. fisheries unknown, the United States of America must be regarded as the largest fishing industry in the world. With fisheries, quick-freezing and storage plants, canning, curing and distribution highly developed, the production and supply of fish

and fish products in the U.S.A. is larger than in any other country.

The annual supply has reached 4,400 million lb. of fish. A detailed analysis will be found in the form of a graphic illustration overleaf.

There are altogether about 125,000 fishermen in the U.S.A. of which 65,000 are regularly and fully employed on fishing. about 32,000 are working on vessels over 5 tons each.

The annual catch of the American fisheries comprises the following varieties and average quantities during the last five years are as follows:—Pilchards (Sardines), 418 million lb. of which 152 million were canned, the remainder being used for oil and meal; Mackerel, 52 million lb. of which 37.4 million were canned, the remainder used for by-products; Herring, the U.S. catch varies enormously having been as low as 45 million lb. in one year and risen to 210 million lb. in another.

Other catches are (in million lb.): Sharks, 40; demersal fish comprise sole with about 36, halibut with 50, cod 8.6, lingcod 6 sablefish 7.6.

The balance of the entire catch is made up of a great variety of fish, mostly demersal, also shellfish, tuna, sword and spear fish hake, whiting, pollack, rosefish or redfish (the catch of these amounted to 145 million lb. in 1941 on the Atlantic coast of the U.S.A. and Canada), snook, black drum, etc., etc.

Exports of canned fish are normally of considerable importance and in 1946 the latest year for which detailed figures are available, abnormally larger quantities were sent overseas because of U.N.R.R.A. purchases for relief purposes.

Exports of the various fish varieties in 1946 were as follows:—

	Quantities lb.	Value $
Oysters, fresh, frozen, etc.	805,720	463,64[illegible]
Shrimps, fresh, frozen, etc.	410,190	207,65[illegible]
Shrimps, dried	497,174	456,33[illegible]
Salmon, cured, etc.	1,339,040	492,10[illegible]
Cod, hake, salted, etc.	1,825,621	305,57[illegible]
Herring, cured, etc.	1,856,827	235,00[illegible]
Other fish, cured, etc.	6,360,000	1,500,00[illegible]
Canned Salmon	51,358,000	12,889,90[illegible]
,, Sardines (Pilchards) ...	85,727,600	13,360,30[illegible]
,, Herring	3,378,000	520,40[illegible]
Fish, others	18,600,000	3,200,00[illegible]
,, Shellfish	—	4,600,00[illegible]
Other edible fish products		1,000,00[illegible]

The United States are, however, also importing sizable quantities of fish in every stage of processing, especially quick-frozen and cured fish. The following details of imports during 194[illegible] will give a good idea of the volume, and the varieties:—

	Quantities lb.	Value $
Whitefish, fresh or frozen	795,500	236,200
Yellow Pike, Jacks or Grass Pike, Lake Trout, Perch, Lake Herrings, (and Chubbs), Saugers, Smelts	4,800,000	880,000
Cod, filleted, fresh, frozen, etc ...	2,103,000	424,000
Other fillets, fresh, frozen, etc. ...	557,500	179,000
Sardines in oil over 9 cm	3,000,000	1,210,000
Anchovies in oil over 9 cm	243,000	167,000
Cod, etc., pickled, etc.	5,300,000	890,000
Cod, filleted, smoked	615,000	145,000
Herring, pickled	925,000	138,000
Mackerel, pickled	1,000,000	175,000
Sturgeon roe, not boiled	70,000	482,000
Lobsters, not canned	2,181,000	782,000
Shrimps and Prawns	1,678,000	580,000

U.S.S.R.

According to Russia's post-war Five-Year Plan the annual output of Soviet fishing industry must reach 2,200,000 tons by 1950. To achieve this the Soviet specialists must not only strive to improve existing fishing methods, tackle, and fish-processing plants, but they must also seek to increase the number of fish in the seas.

The Ministry of the Fishing Industries of the Eastern Regions of the U.S.S.R. reported the fulfilment of its quota for the third quarter of 1947 by September 15th. The catch exceeded by 100,800 short tons that for the like period of 1946, according to the Soviet press. The fisheries of Kamchatka already had more than fulfilled their entire quota for 1947.

An important contribution to this year's catch was made by the fisheries of the Southern Sakhalin and the Kurile Islands. This area is rich in a variety of fish, sea food, and sea animals, including cod, Siberian and humpback salmon, plaice, crabs, walruses, seals, and whales. Herring, however, represented 85 per cent. of total fish reserves .

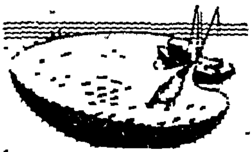
Later reports from the Maritime Territory indicate that the catch of its fisheries at the end of September averaged up to 60 carloads of fish a day.

Venezuela

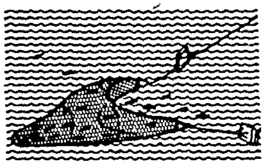
During 1946, a total of 6,432,852 kilograms (1 kilogram= 2.2046 pounds) of fish, valued at 4,353,861 bolivares (about $1,306,158 U.S. currency) was entered for sale in the port of Maracaibo, Venezuela. Of this amount, 1,216,305 kilograms were fresh fish and 5,216,547 were salted fish. The total catch in 1946 was about 3 per cent. less than the 1945 catch.

U.S.A. FISHERIES PRODUCTION

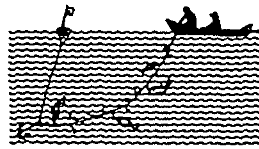
IN AN AVERAGE PRE-WAR YEAR—



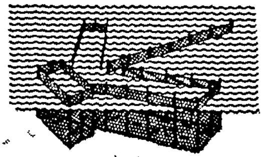
WITH PURSE SEINES,
13,000 FISHERMEN CAUGHT
2,100 MILLION POUNDS



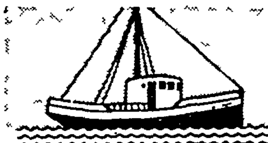
WITH OTTER TRAWLS,
11,000 FISHERMEN CAUGHT
700 MILLION POUNDS



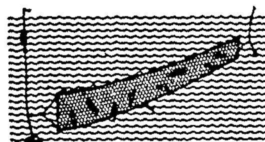
WITH LINES
24,000 FISHERMEN CAUGHT
500 MILLION POUNDS



WITH POUND NETS
6,000 FISHERMEN CAUGHT
400 MILLION POUNDS



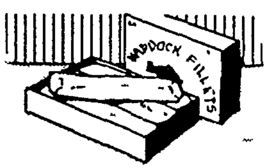
WITH ALL OTHER
TYPES OF GEAR,
19,000 FISHERMEN CAUGHT
500 MILLION POUNDS



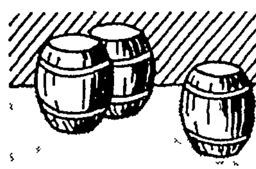
WITH GILL NETS,
19,000 FISHERMEN CAUGHT
200 MILLION POUNDS

THESE FISH WERE PROCESSED THUS:

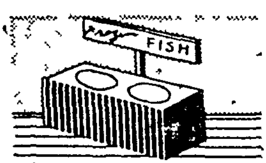
1,500 MILLION POUNDS
WERE CANNED



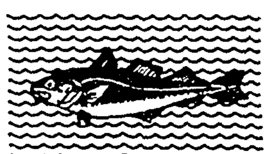
340 MILLION POUNDS
WERE FILLET-PACKAGED



150 MILLION POUNDS
WERE CURED



130 MILLION POUNDS
WERE FROZEN WHOLE



680 MILLION POUNDS
WERE SOLD FRESH

1,600 MILLION POUNDS WERE
MADE INTO FISH MEAL, OIL
AND OTHER BY-PRODUCTS

Illustration by courtesy of the publishers of "Fishery Resources of the United States" edited by Lionel A. Walford.

THE ROLE OF FISHERY RESEARCH

By MICHAEL GRAHAM, M.A., O.B.E.

THE chapter on the nature of fishery research, by Mr. Cushing, shows how all the work is directed towards one ultimate aim—the proper, and controlled, use of the stocks of fish in the sea.

It would, however, be a very great mistake if fishery scientists imagined that the results of every investigation would lead to such a goal within their lifetime. Indeed, these scientists would be very harmful members of society if their first provisional assumption was not against interference with fishing operations and this assumption should hold until it can be shown without doubt that such interference would be advantageous. It is a far happier result if the researches of the scientist show that for the time being a fishery is reasonably safe; and that, as in the herring fishery of the North Sea, he can help to increase catches, or to advise on the provision of handling facilities, by means of biological forecasting. He is still more happy when his researches lead him to indicate the presence of undiscovered fishing grounds, or of unexploited fisheries. An example is the Norwegian prawn fishery, for which the stocks were discovered by Professor Hjort, and which has proved of considerable economic value. The scientist may be also help to increase productivity by recommending transplantation of fish from areas where they grow slowly to areas where they grow fast, as was done by Danish scientists. Our role is not to interfere if we can avoid it, but to help in every other possible way.

However, when experience and the conclusions of scientific investigation combine to show that stocks are being overfished, it is necessary to give bold advice. The boldness is required. because, all too frequently, the investigation that is possible before the state of emergency arises has not been sufficient to provide evidence to satisfy every "doubting Thomas." Here the fishery scientist has to take and piece together all possible relevant evidence, and to make a bold integration on which he bases his advice. Then, although he must be bold, he must not be rash, and has to be particularly careful that his appraisal of the position is absolutely fair. Such fairness is an attribute of all good scientists, but in fishery research it is particularly necessary, because when events press fast in the world of fishing, much of the data may be less complete than the scientist, ever cautious, would wish.

Often it happens that the problem of conserving the fisheries

is an international one. This immediately raises a whole new group of difficulties. When not too many nations are engaged, it may be possible to get them to agree to some uniform regulation of all nationals engaged in a fishery. The fish, of course, have no nationality. A successful example, which we all admire, is that of the International Commission for conservation of the halibut fishery in the Pacific. Even in Europe, where many nations are engaged, it has been possible to obtain agreement on a uniform regulation in some measure, although it is claimed that the regulation is insufficient. Agreements of this kind are those embodied in the Conventions of 1936, 1943 and 1946, applying to the North Sea. In these Conventions most of the European countries agreed to introduce uniform mesh regulations and size limits for fish.

The future, however, does not seem to lie in uniform regulations applying to fishermen of many nationalities. It is but rarely that, when many nations are engaged, the stocks of fish are exactly the same. Thus Norway is more interested in cod and herring than in other species; and Holland is perhaps most deeply interested in the plaice. Furthermore, the methods of fishing differ in each country; and the market also differs noticeably. It is said that in France the housewife does not care to buy her fish cut about in any way, and she therefore prefers to have fish of the right size for the family, often of smaller size than would be popular in the English market. All these are good reasons for trying to find some effective, but flexible, means of benefiting the fish stocks.

Some nations can obtain their fishermen's co-operation in working a close season; some in increase of minimum sizes of mesh; some in limiting individual catches or total landings, or total fishing power. All these methods can have the same effect —that of giving the fish more time to grow—so there can be no objection on natural grounds to a diversity of method. But none of these methods are effective automatically. A watch has to be kept against compensating changes arising: a close season, for example, would be of no avail if the fishermen fished more intensively outside the season, and control of total quantity landed could yet permit overfishing, the quantity coming to be made up more and more of smaller fish. Consequently, such control shows up the only principle on which fisheries can be conserved, namely on mutual understanding, and on confidence that no large group of fishermen are willing to render the conservative measures useless. Of course, there will always be some who will try to beat the regulations, or fishermen would not be fishermen. But, provided the majority keeps this minority in check, there is no reason why a variety of conservative measures should not succeed.

Such a flexible control clearly demands an international

clearing house of information and advice—watching the situation in the fishery. It is on such lines that the British Government is prepared to go ahead: each nation contributing something substantial to the conservation of fish stocks, choosisg a method that is applicable to the conditions within its own nation. Obviously this way forward is fraught with many difficulties, and no firm forecast can be made of what the effect would be of the policy initiated by the British Government. At the same time, when something quite novel is attempted, after thorough study of all aspects of the situation, and when representatives of all the countries are agreed on advising a trial of the novelty, no man can safely say in advance that the novelty will fail.

So, fishery research aims at the best use of fish stocks—gladly helping when increased catches are possible, and advising when control becomes necessary.

THE NATURE OF FISHERY RESEARCH

By D. H. Cushing.

WHENEVER man has lived by the water he has searched for the food that lives there, by rod, net or floating factory. So, fisheries spring up around the world's shores: fisheries for whales and prawns, squids and pearls, cod and herring. Methods are common all the world over, practised from ages of experience and observation of the waters.

In 1874 the *Challenger* returned from her voyage of discovery around the world. The results of the expedition led men's minds in two directions. The first was the abundance of life in the sea, even in great depths, and the second was the question of whether there was limit to this abundance. Huxley and McIntosh in Britain advocated the free exploitation of this abundance, which they believed to be unlimited. Any answer to the question needed quantitative work and this was started towards the end of the last century by such people as Holt and Fulton in Britain, Petersen in Denmark, Hjort in Norway, Heincke and Hensen in Germany. They started work which continues today in marine laboratories all over the world. One typical method of research is the marking experiment, in which fish are marked, measured and released; the startling result of 35% returns a year has been the foundation of much research.

Such work, to be valid, must be accompanied by a study of environment in which the fish live, the water they swim in and the food they eat. The hydrologist studies the water, its movement and changes; the biologist studies fish food drifting as microscopic " plankton " in the water or settled on the sea bed as " benthos." The plankton is susceptible to fairly quantitative treatment by using standard silk nets under standard conditions; quantitative assessment of the benthos is only possible when using a bottom sampling grab. These are the methods by which the background is obtained to the direct work on the fish populations.

Hydrologists are men who study the physics and chemistry of the sea. With accurate thermometers, temperatures over wide areas and different depths are measured; the concentrations of salt, oxygen and nutrients are found chemically; the penetration of light into the water in all its colours is measured with photoelectric cells suitably filtered; the drift of waters is measured by the path of floating bottles and by the records of current meters hung below lightships. The hydrologist interprets these observa-

tions, and they are used in fishery research to find the effects of currents, temperature, salinity and light on the fish populations and their food.

EFFECTS OF CURRENTS

The most striking effect of currents on fish is the direct one. The sunfish and their weakly swimming relatives are occasionally drifted into British waters from tropical seas. Fish travelling in the Gulf Stream are sometimes killed when they meet the cold Labrador current in the neighbourhood of the Newfoundland Banks. Such an event may have been the cause of the schooner *Navarino* finding 150 miles of dead fish; and in the Barents Sea capelans die when the sea temperature changes too quickly. A warm current runs along the southern shores of this sea and a Polar current runs along the northern part; and the banks where the two currents meet are the principal fishing grounds. So Arctic skippers from Hull, Grimsby and Aberdeen are today supplied with deep sea thermometers to assist them in finding these grounds.

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Many fish make a spawning migration to the breeding grounds, and subsequently a reverse movement to the feeding ground. Salmon swim upstream to the right place, and when spent, they drift down the river again to the sea, to feed. In the sea also, fish swim against currents; spawning cod move around Iceland against the Irminger current and afterwards they drift back with it. Some plaice transplanted to the Shetlands before spawning moves round the Islands against the current. Herring from the North Sea muster off E. Anglia, and move into the English Channel towards the Seine, to breed. Their return, drifting with the current, provides the Dutch and Belgian fishery for spent herring in the early spring. It has been guessed that such a movement is the relic of a migration into the delta of the Rhine when Britain and Europe were one. 15900

The identification of currents by means of the plants and animals living in them has been of interest ever since the time of Captain Folger; he was a Nantucket skipper who knew the Gulf Stream because whales lived on either side of it but not in it. He was therefore able to navigate it more quickly; on his information Benjamin Franklin arranged for a fortnight to be saved on the Falmouth packet. In general, plankton species drift in the currents: there is a northern drift of plankton away from the Antarctic towards the warmer water, where it sinks; Caribbean forms appear in the Bay of Fundy, and Mediterranean forms come into the North Sea. Sometimes it has been possible to say that there are "indicator" species, which, fitting their environment closely, may indicate the movement of the water-masses that contain them. Very salt water, which appears at intervals of a dozen years or more in the northern North Sea, may be indicated

by the presence of *Salpa;* other salt water, which comes into the English Channel from the Ushant direction, has been christened the Hebes current because it nearly always contains *Euchaeta Hebes.*

Currents in deep water are sometimes rich in nutrient salts because the plankton life needing the light at the surface has not been able to exhaust them. Consequently, where such currents strike banks or coasts, there is a continuous supply of nutrient salts for the plankton populations. Such a current, and it is a great current, strikes the Antarctic continent, and large quantities of nutrient salts upwell there, giving rise to very dense plankton; and this is the basis of the whale fishery in which 17 floating factories are taking part at the moment. Similar but smaller upwellings take place off Peru, on George's Bank off New England, on the S. W. Patch of the Dogger Bank in the North Sea, and off the West African coast (where there is an unexploited fishery of mackerel, bonito, tunny and hammer-headed sharks).

NATURE AND BEHAVIOUR OF PLANKTON

Plankton consists of plants and animals, the animals grazing on the plants. The latter need only phosphates, nitrates and light for food. Light confines activity to the depths to which it penetrates, and possibly regulates the nightly vertical movements of the grazing animals, which include such fish as the herring and the hake. These plants and animals are confined to fairly narrow temperature and salinity ranges, and the behaviour of the plankton is partly decipherable by hydrological methods. Temperature and salinity are limiting factors to the distribution and succession of plants and animals; and the nutrient salts, which in one place can upwell to produce a fishery, can in another be exhausted, and then the plankton vanishes. This is a usual state of affairs in those tropical seas where there is no upwelling because there plant production is constant instead of seasonal; so nutrient salts are always in low concentration instead of being replenished in the winter, as they are in the temperate seas.

Under certain conditions plankton can grow to a great density; the sea becomes coloured white, red, green, or yellow with floating plants—such coloured patches were seen by William Scoresby and were described by him as "unicellular algae." Plant plankton in such visible density may become so thick as to oppose the movements of fish and in some cases to kill them. A plant, *Gonyaulax* appeared off the Californian coast at San Pedro in 1902, and multiplied till the sea stank, parasites crawled out of the sea cucumbers, and dogfish died. In 1947 fish were killed on the coast of Florida by a great outburst of a related plant; off Madras the Milk-fish is killed by the clogging of its gills by *Trichodesmium.* In 1927 the herring off the E. Anglian coast

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were diverted by a great mass of plants, which probably, however, did not have a directly lethal effect.

Plants may increase so rapidly in the sea that the animals are not able to graze them down quickly enough; so great plant patches develop which are edged with grazing animals. In the antarctic the great plant patches are edged with krill, a shrimpish animal which is the main food of the Blue and Fin Whales. As krill lives on the border of the S. Georgian plant patch, the whales are limited to the border also. The plants use up phosphates quickly and so a high phosphate concentration indicates a lack of plants; it was found that the whale catches could be related to the high phosphate concentrations.

Fish have different types of food at different ages and at different places. The bottom living or "demersal" fish feed on the worms, whelks and starfish, which live there; if these fish move about, as we have seen they do, their food is bound to change. As the benthos in different areas varies, so the condition of fish will change. Small plaice were caught off the Danish coast, marked and liberated on the Dogger Bank. When caught seven months later they had increased in weight six times as much as those similarly released off the Danish coast. This was because the quantity of available food was relatively much greater on the Dogger than on the Danish coast.

Most demersal fish have a larval stage which is planktonic; the halibut fry or cod fry live for a few weeks at the surface and feed on the planktonic plants and animals whilst they are being drifted away from the spawning grounds. In this way they resemble the "pelagic" fish, which always feed on the plankton; the mackerels, herrings, whales, coryphaenas and basking sharks are direct plankton feeders; they are somewhat oily and either have a very high growth rate or are very active. The quantities of available food on the sea bed are difficult to estimate, but it is fairly easy to estimate the quantities of available food for pelagic fish and for the larvae of demersal fish; this can be done by planktonic methods. The comparison of stomach contents with the plankton density in the water surrounding the fish shows which are the important food organisms. The extent of survival of the larval fish might be related to the density of these significant organisms; in the English Channel a relation has been shown between the winter phosphate concentration and the baby fish populations in the subsequent summer. Cod at one season feed on crabs living on the sea bed; at another season they feed on the krill swimming in the middle waters. So some day, the cod shoals may be found by using a special deep water tow net shaped like a torpedo. Herring in the Shields and Fraserburgh fisheries feed mainly on *Calanus finmarchicus*, an oily little shrimp, which was christened by Bishop Gunnerus at Uppsala. The position of

the herring fishery has been shown to be located on the patch of Calanus and those skippers who have carried small metal tow nets to find Calanus have had appreciably higher catches.

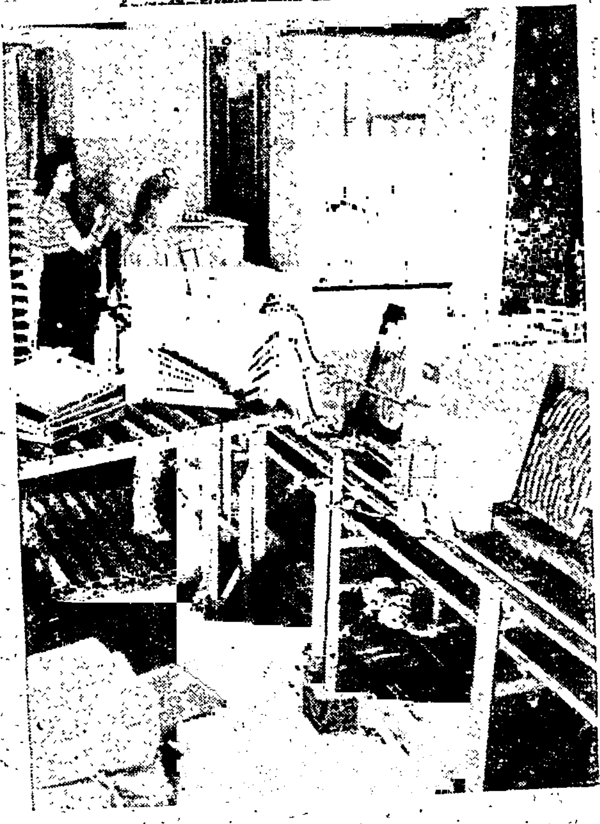
THE COMMUNITIES IN THE SEA

With data of physical and chemical conditions and of currents in the waters obtained from the hydrologist; and with the knowledge of the density of plants and animals living at the surface and on the bottom; it is possible to obtain a picture of the interwoven communities in the sea. Each animal has its place in a food chain, in which it feeds on a plant or another animal, and in many cases is itself the food of another animal. So, quantities of available food are subject to many changes through competition; a fishery may be diminished because of competition by a species which is not edible or catchable. Thus young flatfish were eliminated from Bigbury Bank by starfish which ate a shellfish called *Spisula*, the staple food of the young fish. This sort of competition can only be estimated by obtaining numerical values of the available food at all stages of the fishery. Another type of competition is direct attack or predation; sea gooseberries and arrow worms feed on fish eggs and on the planktonic fish larvae. The bonito feeds on mackerel; cod feeds on cod, dogfish and killer whales feed on the herring. The losses due to natural predators are difficult to estimate. There is one estimate which been made that of the effect of predator man on the fish populations, and this has been the main achievement of fishery research.

We have seen how the first of the *Challenger* problems, the abundance of the seas, is dealt with in fishery research. This is largely a problem of available food and the conditions which produce it. The second, the problem of whether there is a limit to this abundance is more concerned with the fishery and the fish populations themselves, and is the more urgent task of fishery research.

Our knowledge of fish populations is derived partly from market statistics, which are the measurements of the fishery. The fishery as distinct from the fish population is subject to many factors which bear no relation to the fishes, although such factors will have their effect on the numbers of the fish: the extent of trade, the demand for fish, working conditions, affect a fishery, but would change the fish only indirectly. It is necessary to take into account the extent to which the ships cover the fish populations and so make market statistics into adequate samples. This even applies to parts of a thoroughly dragged place like the North Sea. Market statistics, however, are the basis of all the work done, and the more efficient they are, the better will the final approximation be.

The first task of the biometricians who measure the fish



Above:
Scientific Control of fish-products at the Torry Research Station.

Left:
Model Quick - Freezing Apparatus at a British Research Station.

(Photos by courtesy of the Ministry of Food)

populations is to indentify the stocks with which they are working. The extent to which oceanic barriers may partly isolate stocks may be used, e.g., the distribution of eggs and larvae is governed by the directions of currents. From the North Sea cod fry do not reach the Norwegian area in any quantity, because they are held in slow swirls, in the North Sea. Again, the Norwegian fry are taken North of the Lofoten Islands, towards the Arctic. Although some Norwegian adults may be found in the North Sea and *vice versa,* the chances are against the stocks of eggs and fry becoming mixed.

This conclusion is backed up by an examination of the fluctuations of the two stocks of cod. A homogeneous population changes in its own tempo; the North Sea cod as measured by market statistics fluctuates independently of the Arcto-Norwegian stock. Another way of checking this is by market experiments. Fish are caught, marked alive and released with a numbered button, after having been sexed and measured. This gives information on migration. So, cod which have been marked on the Newfoundland Banks could be found at Bear Island; those marked at Novaya Zemlaya could be found off Georgia. But the point is that they generally remain in their areas and that there are independent stocks of cod in the North Sea, at Bear Island or on the Newfoundland Banks and that interchange between them is the exception rather than the rule. The fourth method of identification is morphological: as might be expected the independent stocks, as separate developing populations, differ in small details and these can be recognized. The pattern on scales and the number of vertebrae are typical characters, and herring may be identified as Norwegian, Icelandic or North Sea, by scale inspection. Such methods as these allow the stocks to be identified quite critically. Such division, with perhaps an estimate of the interchange, increases the value of market statistics greatly because they often apply to independent stocks.

When the stock is identified it is necessary to be able to find its age composition, the growth rate of its individuals and the growth of the population. In practice this job is done contemporaneously with the first, but in method its results can only be used on the identified stock or population. The first method is to measure good samples of fish and to arrange them in an order of frequencies of length or weight; the measurements often tend to show "humps" which may be year classes. This method depends on the seasonal spawning of the fish and the consequent yearly grouping of sizes; it would not apply to those tropical fish, which are said to spawn all the year round. The second method depends on the seasonal growth of scales, vertebrae, otoliths and some bones of fish in arctic and temperate seas, where seasons are distinct; the fish grows faster in summer than in winter and the scale ridges are concresced into an annual ring during the autumn

and winter. Herring scales and plaice otoliths are fairly reliable and with practice, repeatable readings can be obtained. By this method the age of a particular fish may usually be obtained, and hence the age composition of the sample; adequate sampling methods give the age composition of the stock. The distance between the annual rings combined with measurements of the same individuals, gives an estimate of the growth rate of those individuals; and it is possible to distinguish a good year for growth if many individuals have wide rings formed in that year. A rougher way of obtaining the growth rate of an individual fish is by means of marking experiments. From the yearly comparisons of ages in samples, the trend of age groups can be foreseen. Consequently it is possible to predict within limits the forthcoming age composition. This is carried out for the E. Anglian herring fishery. But there are some interesting extra factors here: the majority of the fish are caught in full moon. Plant patches sometimes interfere with the fishery as they did in 1927 and the winds make a considerable difference, S.W. winds being favourable.

Age samples and market statistics do not precisely represent the population of fish in the sea. If we want to know what the whole stock is, then we must use other methods. The first of these methods depends upon the floating eggs of demersal fish; this allows them to be estimated fairly quantitatively by planktonic means. Over an area the total number of eggs in the water is calculated from those counted in adequate samples; if we know the number of eggs laid by an average female fish, then we know the number of spawners in the area in question. This has been applied to plaice of the Southern North Sea.

Another method is by means of marking experiments. Here marking experiments may be carried out over the whole area in question or may be done intensively over a part of that area. The percentage return of marked fish when applied to market statistics will give the percentage of the stock fished. This, besides giving an idea of the fishing rate, will give a figure for the stock in the area, which can be compared with that obtained by the estimation from floating eggs.

"THE OVERFISHING PROBLEM"

The purpose of this study of populations, their growth and their numbers is the solution of the problem of overfishing, the problem of the limit to the sea's abundance. Numbers of fish surviving over the years show the effect of predator man on the fish populations as he uses them. Man has gradually improved his ships, his gear and his technique. The effect of these in some areas in recent decades has been that the fishing effort has increased, but the yield has only increased a little and then has fallen quickly. This has been shown in the history of the Pacific halibut, North Sea

plaice, cod and haddock; and in the Atlantic hake. There was first a decline in stock and then a sustained yield as ships sought further grounds or slightly improved their gear, the most important of these changes being the introduction of the Vigneron-Dahl gear. The fish declined in size as all the catchable fish were taken up. The evidence for heavy fishing was largely confirmed by two world wars, when fishermen were occupied on other jobs; the fish stocks after the first world war had recuperated and this was followed by boom and decline. In the second world war when normally penurious inshore fishermen paid excess profits tax, the same effect was expected, and found.

To overfish is to fish the stocks into decline, first decline of average size, then possibly, decline of numbers. So the whole conception of overfishing implies an optimum fishing rate at which the stock or population may be fished without loss to the fishery. There are three types of work involved in the establishment of a good fishing rate. The first is the measurement of the present rate of fishing by means of marking experiments, as already indicated. These coupled with market statistics give an estimate of the stock. This estimate is clarified if there is a measure of the intensity of fishing by different ships and by different gear; then we can say, on looking at the market statistics that different fishing efforts were distributed in such a way and so obtain a better value for the fishing rate. Therefore we need tests between ships, which is called comparative fishing, some of which has been carried out in the North Sea, coupled with tests of different gear. This type of work will lead finally to an estimate of the fishing rate under various conditions of intensity, and therefore to an optimum fishing rate. Connected with the optimum fishing rate are mesh experiments, gear experiments and more comparative fishing, to obtain the most useful application to the fishery of the theoretically established fishing rate.

This was the aim of Holt and Fulton; they with Hensen and Petersen saw the implications of the *Challenger* expedition and were well aware of the extent and nature of the work necessary. As men and ships extend the work over the sea, new problems, new fisheries will become available; it is for this purpose that Britain is equipping a large new research ship, the *Ernest Holt*, to explore the Arctic Fisheries.

DEVELOPMENTS OF BRITISH SHIP CONSTRUCTION FOR THE FISHERIES

By W. WILSON

THE design of a modern fishing vessel presents a number of problems not normally encountered in the design of any other class of sea-going vessel. There is nothing standard about trawlers, drifters and other vessels, nor is there likely to be, each fishing company retaining its own very definite ideas about the essentials and impossibilities of design. As owners are able to lay down comparatively fine limits, the specific duties demanded of the vessel, the tonnage to be carried, the sea areas in which she will sail and the speed required to ensure a quick but economical return with the cargo, no one design would possibly meet all individual requirements.

The outbreak of World War II found a greater number of fishing vessels than was required to produce the fish for those markets still available. While many of these were adopted for a variety of naval purposes, a great number of the remaining vessels were in very poor condition. Despite the addition of special Admiralty types throughout the war to replace losses, there is at present a great shortage of modern, efficient fishing vessels and equipment.

The task of reconditioning many of the vessels would scarcely justify the expenditure, with so many advantages to be derived from advances in the fields of marine propulsion, welding technique, the use of new materials and the great progress in the design of hulls to give increased efficiency. With so many developments appearing practically simultaneously, selection of equipment becomes an increasingly difficult problem

The diesel engine has undoubtedly gained acceptance as a reliable and economical means of propulsion, having a great advantage over the steam plant in burning fuel in the proportion of approximately 0.4 lbs. per h.p. compared with 0.9 lbs. in an oil-fired steam engine; and 1½ lbs. per hour for a coal-fired steam plant. The diesel engine industry was quick to realise the needs of fishing vessels and many special designs considerably reducing the weight and space occupied were evolved. However, there still remains a strong demand for the steam reciprocating engine—a preference prevalent no doubt because of the simplicity and reliability of this type of engine under most adverse conditions.

Efficient and well-designed oil burning equipment is replacing the coal-fired boiler, higher and more constant pressures are greatly reducing the operating costs, while the maintenance costs of this engine are normally very low as compared with other propulsion units.

An interesting vessel which made her appearance earlier this year was the *S.S. Padua,* built and engined by an Aberdeen shipbuilder, for the Newfoundland cod fishing service of Empresa Comercial de Pesca, S.A.R.L., Lisbon. One of the largest trawlers yet built, the *Padua* is 1,350 tons gross and has dimensions of 238 ft. overall length, 35¼ ft. breadth and 19¾ ft. depth, with a fish-hold capacity of approximately 41,000 cu. ft. Her total complement of 61 men are berthed in comfortable accommodation with every modern facility. A cod-liver oil extractor is placed at the forward end of the midship house and a 24-ton storage tank arranged aft. This vessel is fitted with triple-expansion engines, superheated steam at 220 lbs. per sq. in. being supplied from 2 oil-fired multitubular boilers. With a long range assured by her bunker capacity of 650 tons, the *Padua* is well provided with most modern navigational equipment, including wireless direction finder and echo-sounding apparatus.

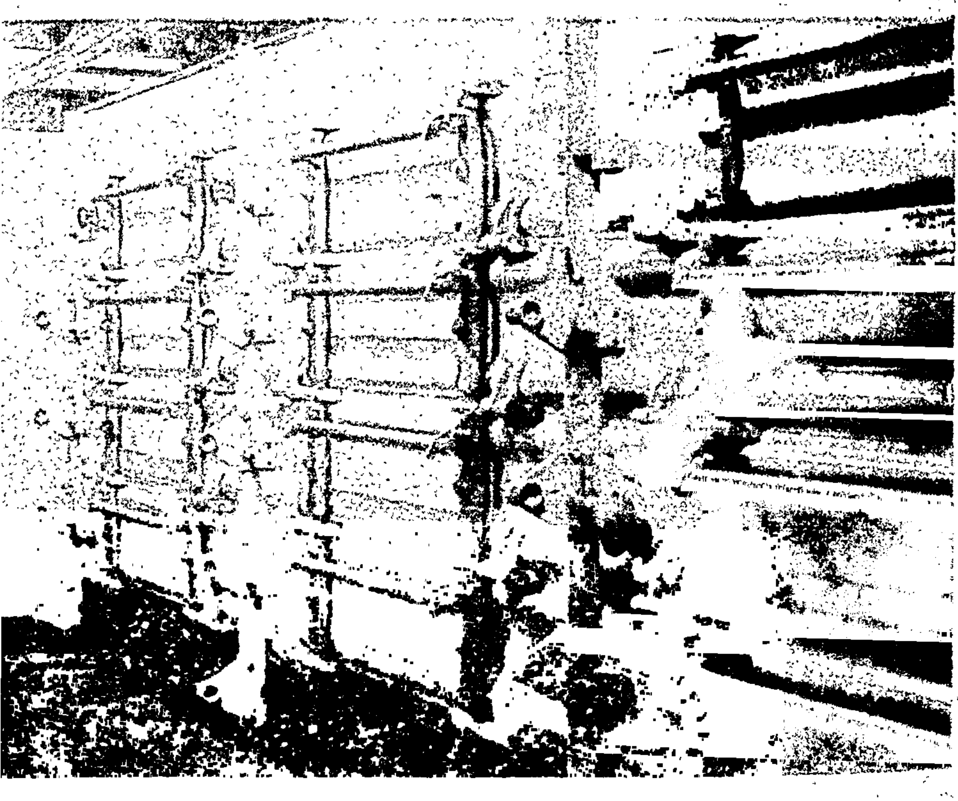
Considerable interest was shown in the CROSSLEY diesel propulsion unit supplied for the Belgian trawler "Belgian Sailor," built by BELLIARD CRICHTON & CO., Ostend. This direct-reversing Crossley engine was stated to be the largest exported of that type by Crossley's and incorporated their latest technique of "exhaust pulse pressure charging"—a system greatly attractive by its simplicity of operation. This engine, the H.R.L. 6/34 two-cycle, single-acting, airless-injection class, develops 450 b.h.p. in 6 cylinders at 340 r.p.m. The power is transmitted through helical reduction gearing and this is claimed to improve towing performance by as much as 25 per cent. From a fly-wheel at the forward end of the engine, a belt drive transmits the drive through the foreward end of the superstructure to the main trawl winch. This drive can be disconnected from the main engine to give full engine power on the winch when required. Normal manoeuvering of the engine can be controlled from the wheelhouse.

Freezing of Fish at Sea

As the first British ship to incorporate quick-freezing facilities, the "Fairfree," a former Algerine class minesweeper of 1,500 tons gross, has been described as a prototype on whose succesful operation the future design of such ships will depend. The need to provide extra accommodation, refrigerating equipment and hold space dictated the adoption of stern handling of nets instead of the normal side handling general in the trawling industry where low-sided vessels are standard. The main feature of interest is the Burnley freezer—an aluminium, all enclosed, side feed unit with

twelve doors, three divisions and 32 trays to a division. Blocks of fillets placed in this unit weigh approximately 2 lb. and the output is said to be 1 ton per hour. The shelves of the freezer consist of parallel tubes linked to the brine supply and have a system of fins which give a flat freezing plate upon which the trays rest. Special devices have ensured that the brine will be brought to minus 30 degrees Fahr. to bring the fish to minus 20 degrees Fahr. no matter what emergencies may occur.

While machine filleting is expected to be installed as a later development, the present policy is to operate by hand, the fish



Burnley Freezer Installed on Board F.V. "Fairfree."

then being stored in special aluminium trays designed to allow partitioning to store the various sizes of fish.

The use of aluminium in the marine field has increased rapidly as the direct result of the extensive research organised by the Aluminium Development Association into a number of fundamental problems. Such development researches are described as being but a part of the Association's long-term development programme which ultimately aims at the construction of prototypes of aluminium ocean-going ships. A drifter-trawler recently launched at

Brooke's Yard, Lowestoft, was believed to be the first vessel of its kind in Britain to have superstructure of aluminium alloy. This material, supplied by the Northern Aluminium Company, is extremely strong and has the immense advantage of being highly resistant to corrosion. Other advantages to be derived from its adoption are the reduction of top hamper, less interference with the magnetic compass and the fact that the capacity of the holds can be increased. The capstan of this vessel, incidentally, is specially deigned for drifters and is fitted with a whipping drum running at a suitable speed, the speed and power being operated by a simple valve at the capstan.

Diesel-Driven Trawl Winches

With more diesel-powered vessels making their appearance, there arose the demand for an alternative to steam for operating deck machinery, particularly trawl winches. Intricate machinery was out of the question, and VICKERS-ARMSTRONGS, LTD., realising the demand, produced a simple method to link a diesel engine to a winch, yet retaining the characteristics necessary for trawling. The unit first produced incorporated a standard three-cylinder, four-stroke McLaren diesel engine developing 66 b.h.p. at 1,000 r.p.m., "V.S.G." hydraulic transmission gear and an Elliott E. Garrood twin-barrel winch. The auxiliary diesel engine is direct coupled by flexible coupling to a "V.S.G." pump unit, and on board ship both the engine and the pump are situated in the engineroom, the pump being connected to a reversible hydraulic motor on deck, driving the winch. A handwheel adjacent to the winch governs the speed and direction of the winch by controlling the stroke and output of the pump unit. Designed to operate a normal winch pull of 1½ tons at 200 ft. per minute, or 2 tons at 150ft. per minute, this equipment has a maximum pull of 6½/7 tons which is controlled by a special safety device so that in the event of the trawl meeting an underwater obstruction, the speed of the winch is automatically reduced until normal tension is restored. Should the pull become excessive, the winch comes to a standstill and in extreme cases may be caused to reverse, thus protecting the whole of the equipment from engine to rope. This type of equipment should meet the requirements of the average trawler, but smaller or larger sizes can be supplied.

There have been certain diesel-engined vessels in which a generator has been arranged at the forward end of the main engine, clutch controlled, so that when the main engine is not propelling the vessel, power is generated to drive the electric trawl winch. This arrangement, however, has not gained general favour. A more popular arrangement is the utilization of the waste heat from the exhaust of the engine. This exhaust, if from a four-cycle unit, can, by passing into a thimble tube boiler of the Clarkson or Spanner type, generate sufficient steam to drive all auxiliaries and winches. When the speed of the engines is decreased, the boiler is

automatically oil fired and then operates as a normal oil-burning unit.

Hull Protection

The heavy expenditure involved in combating corrosion has long been realised, and considerable attention has been concentrated on evolving better processes and materials to resist such actions. Painting, of course, appears to fulfil the requirements and it is naturally generally accepted that the metal should be well protected before the application of the paint. It is rarely indeed, however, that the surface is properly prepared, since nothing short of shot blasting or chemical treatment can adequately clean such surfaces.

A system has recently been evolved by the SCHORI METALLISING PROCESS Co., by which the metal is prepared by shot blasting and a protective coat of metallic zinc applied by a special pistol. By this means, complete protection is claimed for the metal and a perfect anchor provided for the paint, ensuring longer life for both paint and hull. For many purposes a coating of metallic zinc alone can provide adequate protection.

Another interesting experiment which promises good results is the method of flame cleaning the hull—a process recently carried out by the Shell Group on one of their new tankers now building in the Tyne. Research confirmed that a 12-knot vessel running at a speed of, say, 11½ knots, lost as much as half-a-knot in every five years' service due to the deterioration of the surface of the plates and the consequent increase in skin friction. This loss in efficiency, it was decided, could only be overcome by removing the "mill-scale" before painting. Experiments were carried out in "pickling" the plates, but flame cleaning was found to give better results. Special oxygen flames heat the plates, which are then brushed and the paint immediately applied before any further oxidation can occur.

While only a few of the many developments in the fishing industry have been covered, there can be little doubt that this industry to-day is one of the most enterprising bodies in this country and fully alive to the increasing demands upon its services and equipment. The industry is becoming highly mechanised, crews more highly trained and technical, and new systems evolved. Higher building prices and maintenance costs can only be offset by a development of more efficient hulls, and machinery giving greater overall economy. Leaders in the British fishing industry have every confidence in the abilities and enterprise of the builders to produce the vessels required to utilise advantageously recent developments and to keep abreast of modern trends.

A NEW HAND BILGE PUMP

WHO has not at some time or other wished ardently for a Bilge Pump which would never choke, has never to be primed, and has the capacity to quickly return the sea to where it belongs! It is claimed that in the "Whale" Hand Bilge Pump these desirable features are all found.

The "Whale" pump for vessels of 35ft. and upwards in length has a capacity of 20 gallons per minute (a useful rate for an emergency) and is so designed that it will pass freely such things as handfuls of cotton waste, fish scrap, whole herring, corks, chips and last but by no means least the ubiquitous match. It has even been known to pump small coal. Herring or other fish scales present no problem to the "Whale" pump for the simple reason that no filter is used. Although the "Whale" pump is of the piston type it is claimed that no priming is ever needed.

This pump is well constructed of high grade materials—gunmetal, naval brass and stainless steel, and weighs approx. 56 lbs.

For ease in handling, a Lever Handle Operating Unit has been designed for use in conjunction with the large "Whale" pumps where the suction lift is 10ft. or more. This lever is worked with an easy to and fro movement of the hand at elbow height. It is quickly and easily fitted, the strong steel tripod being set down on a gunmetal deck plate and secured rigidly by a turn of a gunmetal clamp.

A smaller pump is available for inshore boats and "crabbers."

The large pump is made in two types, one for discharging the water through the side and the other through the pump head on to the deck. Both these pumps have flanged heads and fit flush with the deck. As for the smaller pump it is also available in two types, but in this case one is designed for fitting against a bulkhead and the other through a deck or thwart, both discharging the water through the side. Incorporated in the design of the latter is a telescopic handle which is always ready for immediate use.

This firm has also, by the introduction of the "Whale" Ballbearing Single Fairleads, successfully tackled one of the big problems of Seine Net fishing where the net ropes are brought over both port and starboard sides at the same time.

Hitherto one of the largest expense items in Seine Net fishing has been the cost of ropes. This item on the expense sheet has risen enormously during the past few years, and until now no way has been found to relieve the Seine Net Boat Owner of any part of this heavy cost of rope replacements.

A study of the subject has shown that the rapid wear of ropes arises from several major causes. Some of these are difficult or

impossible to remove, but we have found that one major cause of rope wear can definitely be dealt with, resulting in longer rope life, less wear and tear on the winch, less power required to haul and also effecting a saving in the expense of renewals and repairs to both rail and deck fairleads.

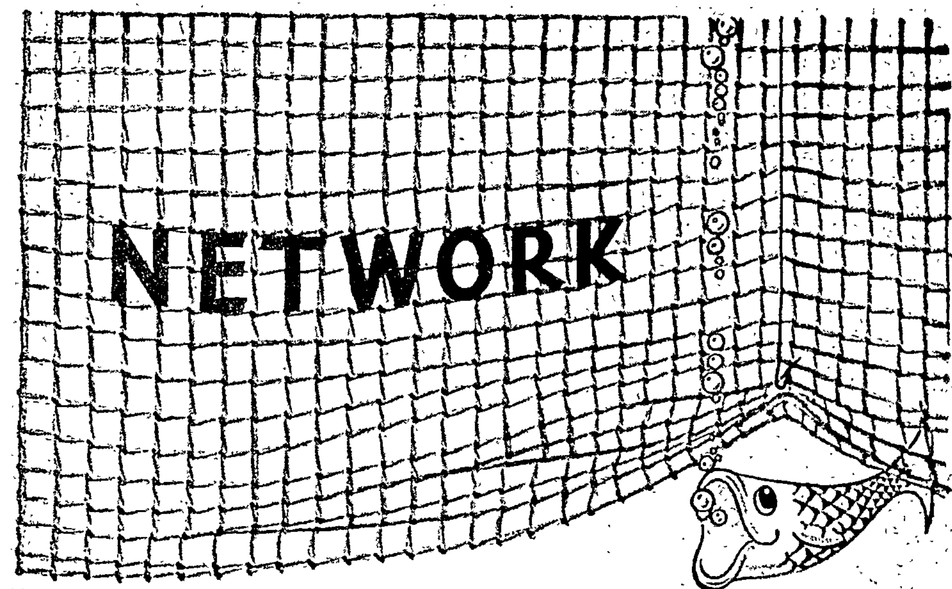
The common type of rail fairlead, in most cases, has cast iron rollers of small diameter (generally from 3in. to 4in.) in diameter. The result is that small rollers working on rusty spindles of large diameter are hard to turn, and very difficult to lubricate effectively in the presence of so much water and mud. In practice they often stop turning, and the rope quickly cuts a groove in one side, after which they have little value as rollers. If the roller is not turning, an extremely heavy additional load is placed on the rope between the winch and the rail, and also where it encircles the winch drum. Under this very heavy strain many fibres in the rope break down, although no outward evidence of this may be seen at the time.

Even if the roller will turn, its diameter is so small that under certain conditions the rope is being very sharply bent while heavily loaded, causing continuous disintegration and fracture of many of the fibres as it is dragged over the small unwilling roller.

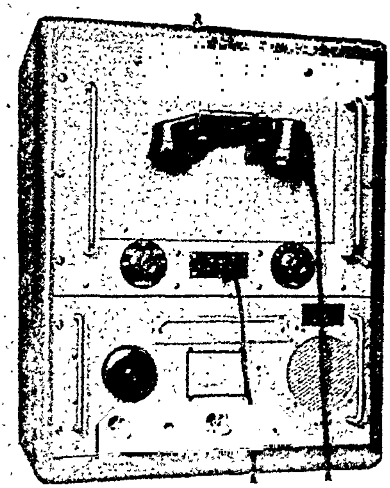
In the "Whale" Fairlead each rope comes freely in over a single sheave of large diameter, instead of being bent sharply and dragged over small rollers. This sheave is so carried that it will receive the rope at all angles of hauling (even when the boat is pitching and rolling), and at the same time give the rope a correct lead to the deck sheave or winch drum. To minimise friction the sheave is mounted on two rows of sealed, waterproof, self-lubricating ballbearings of ample size to carry the load, so that it turns perfectly freely even under the most arduous conditions. These bearings are permanently packed with petroleum jelly, and should not be opened as they retain their lubricant indefinitely.

For this type of Seine Net fishing, where the net ropes are brought over both port and starboard quarters at the one time two single fairleads are employed. Standard rail plates and deck fittings are provided so that the fairleads may be fitted to any selected position on the rail. Usefully mounted ballbearing deck leads have also been designed to go with the rail fairleads. As in the case of the pumps it is claimed that only the best materials are used in "Whale" Fairleads which, we understand, have been developed after months of work under practical conditions.

For those boats, which when Seine Net fishing, bring both ropes over the one side the problem is somewhat different. We understand that this firm working on this problem, and no doubt more will be heard from them in the near future. They are also developing a "Whale" light weight Power Line Hauler for long line fishing.



The advantages of a radio-telephony network for trawlers, coastal vessels or other small craft will be quickly appreciated by enterprising owners and masters. The low initial cost is rapidly offset by the operational economy resulting from the maintenance of communications from ship to shore and between the ships of a fleet.



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RADIO COMMUNICATIONS FOR THE FISHING VESSEL

By A. J. Holberton.

THE advantages gained by the provision of radio communication facilities on a fishing vessel are already so widely recognised and appreciated both by owners and masters that it would be pointless to re-iterate them. Facts which are not so well-known are the regulations governing the equipment of fishing vessels with radio and the merits and demerits of the different types of equipment available. These notes are a summary of some of the most important factors which have to be considered if the installation is to attain the maximum utility.

First is the position of such installations with respect to international and national regulations. All radio transmitting services are controlled by international regulations framed with the object of ensuring that each can operate with the minimum disturbance and interruptions by others. These regulations are supplemented by national regulations covering the territory and shipping of the individual country.

The basic control is the allocation of sections of the radio frequency spectrum to each service, for broadcasting, aviation communications, amateur transmissions, medical diathermy, marine communications or any other use of radio frequency energy. The most important marine communication allocations are in the Medium and High Frequency sections of the spectrum, with some additional provisional allocations in the Very High Frequency section. These are also commonly known as the Medium Wave, Short Wave and Ultra Short Wave bands respectively

Wireless messages may be passed either by telephony or telegraphy, but as no vessel may be fitted with telegraphy equipment unless a certificated wireless operator is carried, this alternative may be dismissed as uneconomic for any but the largest fishing vessels. Telephony installations may be operated by personnel who hold a radio telephonist's certificate, which calls for a knowledge of calling procedure and distress regulations, and the ability to operate the radio telephone equipment installed, a standard which can readily be attained without technical knowledge or training.

As there are no allocations for marine telephony services on the M.F. (Medium Wave) bands, the next consideration is a choice between H.F. (Short Wave) or V.H.F. (Ultra-short Wave) tele-

phony equipment. The characteristics of each type differ sufficiently to simplify the selection of the correct type for a particular service. Briefly, H.F. telephony can operate over any range, the limitations being the output power of the transmitter and atmospheric conditions, while V.H.F. is normally limited to little more than the "Line of Sight" or optical range from the sending to the receiving aerial. As regulations limit the power output of these transmitter classes to 50 watts, the respective maximum ranges can be stated approximately as up to 200-350 miles for H.F., with far more under good conditions, and up to 15-25 miles for V.H.F. This extra range of the H.F. equipment is an overwhelming advantage for the deep-sea vessel.

The short range of V.H.F. can be turned to practical advantage in some cimcumstances as it permits the allocation of the same frequency to two or more networks which are reasonably close to one another. In many instances, the transmitters are of such low power that the effective range is limited to a very few thousand yards, so that two low-power networks can work on the same frequency without interference even when their nearest stations are only a few miles apart. As a result, it is possible for the authorities to be very much more generous in the allocation of frequencies to private or local networks.

H.F. telephony is quite as efficient as V.H.F. at short range and proves very useful for maintaining contact between the vessels of a fleet at sea, though British G.P.O. regulations prohibit transmissions from H.F. installations in harbour areas. As the distances over which it is wished to communicate in such areas are generally little over megaphone range, the more modern H.F. telephony equipments have facilities which allow the transmitter to be used as the power amplifier for a loudhailer, with a range of a mile or so, thereby providing an audio link in place of radio contact.

When considering the installation of marine radio telephony equipment, it should be realised that the cost will increase in proportion to the power output, but it must be remembered that greater power means greater range and emergency safety factor. It is often just when atmospheric conditions are bad or contact has been lost with other shipping that an emergency will arise, and the transmitter of greater power will punch through a message which may mean the saving of a valuable ship with its crew.

On the question of set design, a most important item from the operational viewpoint is the type of transmitter frequency selection and tuning provided, the two main alternatives being master-oscillator or crystal control. Master-oscillator control gives continuous coverage of the whole frequency range of the set, the frequency required being selected and checked by dial or instrument readings. This is not too difficult in operation once it has

been mastered, but for the non-professional operator is liable to lead to inaccuracy at moments when very quick setting is called for.

With crystal control, on the other hand, transmission is simplified to a number of pre-set channels, usually 5 to 8 in number, which are selected by turning a switch, and gives complete certainty that the desired frequency is attained immediately and will stay dead on tune, without drift, as long as the transmitter remains working. It is significant that the latest G.P.O. specifications for marine telephony equipment all call for crystal control, and it is likely that this preference will in due course be reinforced by regulations.

The receiver can also be crystal-controlled or continuously tunable. If it is to operate only with a corresponding transmitter, the crystal is preferable, but if this is not the case continuous tuning shows many advantages, as most ships require a wider range of reception, covering the M.F. marine and broadcast bands as well as the H.F. band. For this reason, it is normally preferable to have a continuously tunable receiver with several wave ranges.

Summing up, the ideal installation for a deep-sea fishing vessel of moderate size would be a radio telephone with the maximum permissible power of 50 watts, having a crystal-controlled H.F. transmitter and a continuously-tunable receiver covering both M.F. and H.F. bands, also facilities for loudhailing, if possible. Details of permitted frequency range, aerial requirements and other technical points can safely be left for decision by the manufacturer, or his agents, who are constantly in touch with the appropriate authorities and are well aware of current regulations.

PROGRESS IN THE TANNING OF FISHING NETS

By S. H. W. JAMES

IN truth has it been said "Time and tide wait for no man." Scientific research and technical progress are in full sail. The British fishing industry does not lag behind.

The present generation is witnessing a change over from steam to propulsion by internal combustion engine. The previous generation witnessed the change over from sail to steam. Before that was the radical change from preserving gear with oak and other barks to the simpler and more convenient form of tannin in solid form imported from abroad.

Led by the largest suppliers in the world of tanning materials, research was undertaken to produce vegetable tannin in a still more concentrated form especially for the tanning of fish nets. The technical experts to whom this work was entrusted had the advantage of knowledge gained in producing vegetable tannins to increase not only the strength and life of leather, but also a wide range of other materials.

Tests were carried out in laboratories equipped to produce conditions identical to those met at sea. Successful results were afterwards put to stern practical tests at sea stretching over a period of three years.

The results of these tests confirmed laboratory findings and established the breaking strain of nets tanned with British manufactured products to be higher than ever before. As a result, labour on repairs to nets has been reduced, and with the life of nets substantially increased the heavy expense of costly replacements has likewise been substantially reduced.

Certain features of the vegetable extracts now supplied by British manufacturers in comparison with those imported from abroad, and which previously enjoyed popularity, will repay close study.

There is a wide variation in the tanning strength of imported materials, which makes it impossible to regulate the quantity of water to be added to yield a solution of the strength to produce the best results. It is difficult to separate the leaves in which the extract is packed, which means the entry of undesirable foreign matter into the tanning cisterns.

The British product is manufactured in factories where the

process is continuously under the supervision of technical experts and highly skilled operatives. In the course of manufacture the product is closely controlled and frequently analysed to assure an exact degree of strength, permitting of a precise quantity always being dissolved in a given quantity of hot water to give most efficient results and prevent the waste of valuable material.

Particular care must be taken in the latter respect. Since the tanning strength of the home produced product is one third greater than that of the imported material, it follows that a correspondingly less quantity has to be used. This outstanding feature cannot be overstressed since if the same quantity of the British material to that of the imported extract is used, not only is there an unnecessary waste of raw material, but the excess tanning is apt to cling to the fibre, and shake off in the form of dust when nets are dried. It is obviously much better to obtain the foregoing advantages by the simple directions given by the manufacturers.

The cost of the imported extract is approximately £85 per ton as against approximately £70 per ton for the British product. Since the latter contains one third more tannin the correct price comparison on a tan-ton basis, i.e., a ton containing an equal quantity of tannin, is £127 per ton for the imported material compared with £70 per ton for British. It is, therefore, very essential to follow the simple directions issued by manufacturers and thereby obtain perfectly tanned nets, at the same time effecting a considerable saving in cost.

Up to the present time no accurate method has been generally used by the fishing industry to establish the qualities imparted to nets by various extracts. The practice has been to depend on a rough thumb and finger test of strength. With complete confidence in their product as a result of experience gained British manufacturers recommend tests of tensile strength to be carried out on the recognised machine used in the cotton industry and as is actually used for the testing of new cotton nets.

Subjecting used nets to this and other rigid tests the most eminent authority on the Continent in the matter of fishnets has pronounced results obtained from the best of the British manufactured products to be higher than from any of the imported materials. These results find reflection in events for not only have British net manufacturers with reputations built up over many years at stake changed over to the British products for the tanning of new nets, but for the retanning of nets it is increasingly largely used, and large quantities are being exported all over the world.

Of late leading British manufacturers have gone one further with the object of meeting fuel and labour difficulties and

to provide for tanning, especially on board ships, to be carried out in a more simple, convenient and efficient manner. Where the imported tanning material was only available in solid form, British manufacturers not only supply it in that form but also in powder and liquid.

Powder contains a higher proportion of tannin and is more easily dissolved in hot water. Liquid is usable immediately on being poured into hot water and is therefore most convenient for use on board.

Powder is supplied in triple paper bags hessian covered of 1¼ cwts. each.

Liquid is supplied in casks of approximately 40 gallons and weighing about 5 cwts. Liquid can be used for tanning on land and sufficient can be there decanted to be carried on board ship.

The qualities of powder and liquid are identical to that of solid, so that the different forms in which the Cutch is marketed can be used under varying conditions with a complete assurance that the *same satisfactory results will be obtained.*

It is apparent therefore that British industry has once again demonstrated its skill to lead the world. It is particularly gratifying that on this occasion it should be for the benefit of the fishing industry by the production of a high concentrated tanning extract in solid, powder and liquid form to meet the varying conditions under which nets are tanned, and to reduce considerably the shortage and present high cost of labour and fuel.

The advantage of technical services offered by British manufacturers both at their laboratories and by visits of experts to advise on the best method of tanning and to supervise actual trials is proving of inestimable value to the small as well as the large members of the industry.

More *than that still* greater benefits and improvements can be expected to result from such close collaboration and examination of difficulties by highly trained technical experts on the spot.

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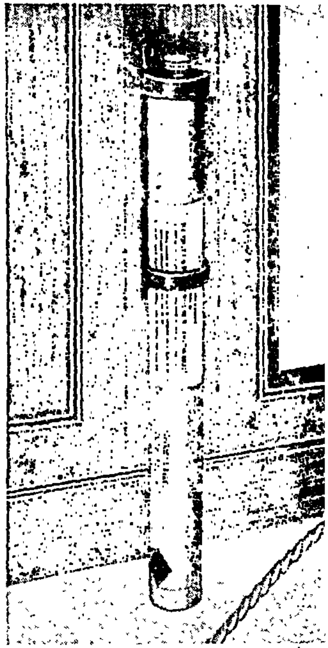

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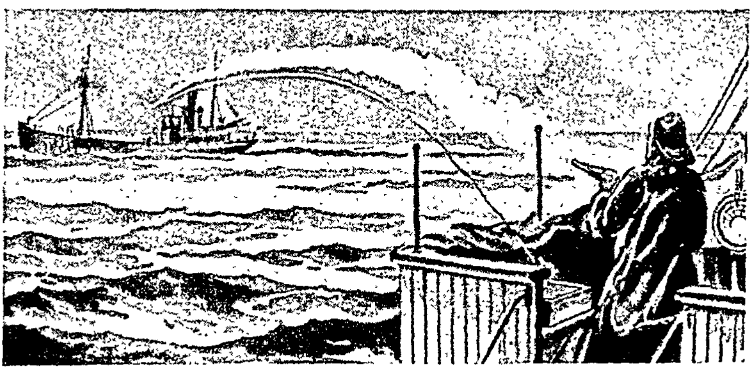

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FISH VARIETIES ON THE MARKET

By ERIC HARDY, F.Z.S.

FOR convenience of grouping, we may distinguish the commercially exploited fish as of two kinds, according to their distribution and correspondingly the places where they are caught. These are the *pelagic* fish, which are the marine fish roaming about the surface of the sea, often covering great distances on their migration and when hunting for their food, and calling for different methods of fishing them as they are more often near the surface. Typical examples are the herring, the sprat, the mackerel and the pilchard. Pelagic fish are able to live both at the surface and in 10-20 fathoms.

This feat is denied to *demersal* fish—the other kind—which live near the sea-bottom and which include most of the commonly trawled fish like sole, plaice, whiting, cod, haddock, skate, ray, turbot and brill. Thus while the demersal cod rarely comes to the surface, the pelagic herring is sometimes caught in the trawl-net when going down to the sea-bottom to spawn.

The main methods of catching fish for the market are by drifters (like the North Sea herrings), trawlers (like the Iceland deep sea demersal fish), line gill nets and pound nets. In trawling both ends of the net are fastened to the stern of the trawler and it is dragged behind, the boat steaming slowly; in drifting, one end of the net is put overboard, and the net paid out after it till all is out, and then the other end is attached to the stem, steam is shut-off and the boat and net drift together. In the morning after the night drifting, or when ready, the vessel steams round and catches the loose end and hauls in both together, as when men fish from a net on the beach. The net is weighted with lead at the bottom and floated with "pellets" at the top, so that it remains upright like a wall and the herring swim against its mesh. Deep sea trawl nets are large, cone-shaped affairs with a mouth 50 to 60 feet wide, tapering to a point closed with rope. The net is slung overboard and towed 1-2 hours across where the skipper thinks the fish lie, then winches are used to haul it to the surface and the mouth and belly of the net are hand-hauled in-board. The fish are crammed in the cone or "cod-ends" to which a rope is hitched from the winch to haul them in, and the end is opened. Hands are gutting these fish when the net has been shot again and is being towed. In the North Sea there are many drifter-trawlers, which catch herring with drift nets near the surface in their brief season, and spend the rest of the year trawling on the sea-bottom

for cod, haddock and plaice. There are two main types of trawl nets, namely otter and beam.

(See illustrations on page 55).

Line gill-nets are used on both sides of the Atlantic but are not so important commercially as trawling. Lines are used in off-shore fishing where the sea bottom is unsuitable for trawling—as at the Newfoundland Banks cod fisheries—when the bottom was not perfectly known. Flat bottom boats use a line a mile or more long, floated at intervals by buoys or casks, and carrying at intervals of six feet short lines of three feet length, hooked and baited with pieces of frozen herring. In some areas lines are dragged through the water by a slow-moving vessel. In the Canadian prairie fishing area winter fishing is carried out under the ice with gill-nets where two men frequently work about 4,000 yards of net, cutting a great many holes through which is pushed a pole with line attached.

True gill nets are perpendicular nets with a large enough mesh for the fish—e.g. salmon—to push its head through but not its body, so that when it tries to get out again it is held by its gill-covers. They are usually set to stakes inshore, or by buoys across a salmon estuary in zigzag fashion, or hanging from buoys they may be drifted with the tide, or worked on lines, as "floating gear." Pound-nets are fixed gear, like trap-nets, staked to form a labyrinth-like trap or impound. Seine nets have ends that can be drawn together to enclose the fish in a circular enclosure, or bag, which can be drawn to the shore.

There are innumerable colloquial names and terms for the main varieties of fish on the markets that are of general importance. In the tables on page 118 these names have been cross-indexed and readers will find a full description of each variety of market fish in the pages preceding this table, together with information appertaining to each fish, such as catching season, and short hints as to how to prepare the fish for human consumption.

The recognised English names of the fish are used for their sequence of order, and for identification the zoological term has been added to each, often also the colloquial name which will be found at the beginning of each note.

A description of the principal fish varieties of importance in world trade follows.

ANCHOVY

(*Engraulis encrasicholus*)

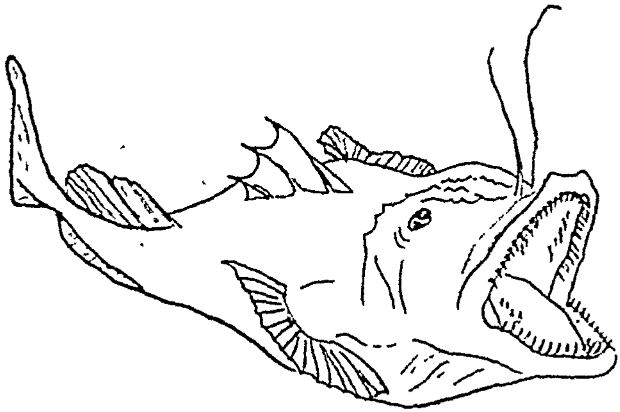
Southern relatives of herring migrating as far as Norway; grows to 5in. or 7in., forked tail, deeply cleft mouth, broad silvery stripe along body, pointed snout projecting above lower jaw, very small teeth, weak swimmer in short, curved dashes. greenish-blue, slender, rounded body, single dorsal fin.

Caught principally Zuider Zee, S.W. England and Mediterranean, especially S. France, Italy, Spain and Sicily, often with sardines. Often caught in nets near flares set on boats at night as anchovy comes in from the sea to spawn June-July. Season summer. Salted, pickled, or prepared in pastes and sauces; used in *hors d'oeuvres.*

ANGLER

(*Lophius piscatorius*)

"Fishing Frog." Enormous depressed, round head with small eyes and huge maw over which dangles long, rod-like tentacle of dorsal fin as it lies on bed in shallow sea with mouth gaping catching fish attracted to the tentacle. Naked brown body:



young smaller and very unlike parent with small head: white underneath. Feeble swimmer: coastal waters. Also called "Monk."

Trawled offshore, Wales (August), South Coast, etc. and occasionally stranded: grows to 30lb. and 5ft. Good food. Head cut off and dark tail sold filleted or sliced as "cod steaks," "silver salmon," etc. Baked in rashers, fried in slices.

BASS

(*Morone labrax*)

"Salmon-Bass." Large silvery marine relative of perches, 9 strong spines in first of its two back fins. Coastal swimmer in shoals near surface, arriving in summer and entering estuaries of rivers, feeding on shrimps, crabs, fish. Grows to 30lb. and 3ft. and migrates as far north as Morecambe Bay. Voracious and fierce.

Season, May-September, esteemed food W. coast of England, Channel Islands and Wales where caught in trawl, or trammel and on line. Flesh rather dry and firm like white salmon. Boiled (like salmon), casseroled, slices fried, or fricasseed like salmon, also collared, or fried like herring. Ingredient of bouillabaisse sauce.

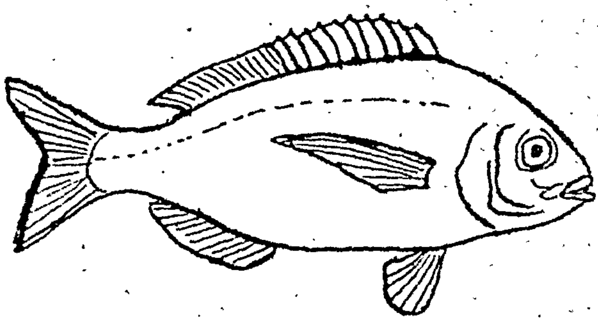
BLOATER

Yarmouth dried Herring, *q.v.*

SEA-BREAM

(*Pagellus centrodontus*)

"Red Bream." Not a true bream; a bottom-feeding coastal fish with large head, single broad back fin with strong front spines, large scales, long breast fins, rich orange-red colour above, silvery belly and a large black spot on each shoulder. Caught in trawls and amongst rocks near shore, I.O.M., Corn-



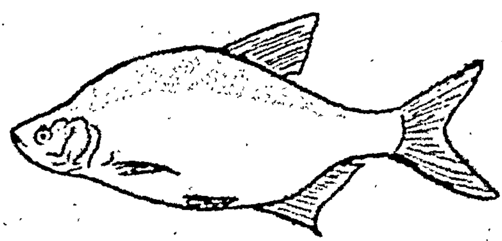
wall, Wales, S.W. England and from boats in deeper water S.W. Ireland; rare North and East coasts. Grows to 7lb.

Season, Feb.-Nov. Eaten mostly in industrial districts of Lancashire as "Bull's Eyes" and "Carp." Also baked as haddock, filleted or fried, when as good as red mullet. Should be cleaned and dried, with scales left on, then grilled, turned often, flouring it when it spits, and when cooked the outside comes away easily. The black sea-bream (Cantharus Lineatus), up to 5lb., also trawled, but very poor eating.

FRESHWATER BREAM

(*Abramis brama*)

"Carp-Bream." Deep-bodied, hump-backed, flat, silvery lake-fish, also in quiet rivers, England and Ireland, except West



Country, in shoals. Up to 13lb. Caught chiefly Norfolk Broads and sold in Midland towns. Season, July-March. Dry and bony, rather tasteless. Boiled like John Dory, and served with piquant sauce.

BRISTLING

Pilchard, *q.v.*

BURBOT

(Lota vulgaris)

"Eel Pout." Freshwater member of cod tribe, European rivers, including E. Anglia and Yorks., a few Severn Estuary. Wide mouth with three barbels or feelers (one on chin and two above), one short and one long back fin, long anal fin; flattened head, long, narrow, brownish body; voracious night feeder on other fish, hiding in holes and amongst stones by day. Grows to 3ft. and 8 lb. Flesh excellent food and one of the best fresh-water fish. Season November-March, but now scarce in England. In best condition at spawning time, late winter.

BRILL

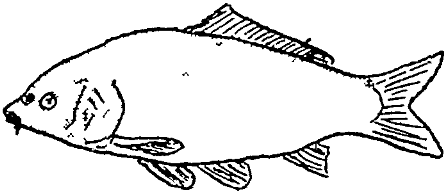
(Rhombus laevis)

Flat fish like turbot, but narrower, longer and covered with slightly projecting smooth scales. Greyish-brown speckled with reddish-brown spots, or darker with white spots according to ground. Left side uppermost. Grows to 13 lb. (Sussex), not found north of North Sea, in season June-April, some places all year. The most delicious flat fish after turbot, and best boiled, when a large brill difficult to distinguish from small turbot.

CARP

(Cyprinus carpio)

Large, bronzy-coloured freshwater fish in clear lakes, often cultivated in fish-breeding ponds, e.g., Germany, Hungary,

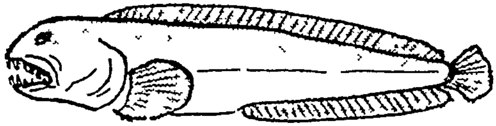


Poland, Palestine, China, and Japan. Round, blunt muzzle, broad dorsal fin without spines, deep body, two barbels or feelers on chin. Grows up to 30lb., on Continent 100lb. and 4ft., but generally smaller from fish farms. Season May-September, or later. Muddy flavour to flesh, needs soaking in salt water, and washing with vinegar and water, medium size best. Scales removed with boiling water. Baked, fried, and served as hot dressed roe of carp. Also *Carpe au Bleu* and *Marinade de Carpe*.

CATFISH

(Anarrhichus lupus)

"Wolf-fish." Like gigantic blenny, named from large



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canine and grinding teeth to tackle shell-fish etc. Elongated body with rudimentary scales, short muzzle with wide mouth and gill openings, long dorsal fin, no pelvics. One of sweetest and most succulent sea fish. Usually trawled off Norway and Greenland. Best sliced and fried.

CHAR

(*Salmo alpinus, etc.*)

Small salmonid, very beautifully coloured, trolled from deep cold lakes. Unlike salmon, teeth confined to head of the vomer bone. When spawning, (winter) back brownish-green, sides lighter, belly orange-vermillion; round white and red spots on sides, dark marks on back fin, red pelvic and pectoral fins. Grows up to 10in. 3lb. Windermere, Coniston, Crummock, Ennerdale, Haweswater, Buttermere, Wastwater, Llanberis Lake (Wales). Allied forms Switzerland, Austria, Bavaria and migratory form found Lapland, Iceland, Scandinavia and occasionally Scottish coast. Lakeland season as with trout. Delicious fish, usually potted. Welsh char, March-October; best autumn.

COAL FISH

See Saithe.

COD

(*Gadus morrhua*)

"Rock Cod," "Codling." Heavy-bodied grey northern sea fish, growing to 5ft. and 100lb.; upper jaw longer with stronger teeth than lower, long feeler on chin. Bottom-feeder; autumn and winter visitor to coast to spawn; cannibalistic. Roe weighs up to 7¼lb. Spawns cold winter weather off Newfoundland, Iceland, Norway, but not south of North Sea. Mainly trawled or caught long lines, North Sea (Dogger Bank), Newfoundland Banks, Iceland, Faroes, Lofoten Banks, Barents and White Sea Banks, for food and for liver-oil.

In season all year; best Sept.-April. Nourishing, best dressed in slices not whole. Baked, fried, salted (with parsnips), boiled (with sweet herbs), also *Morue a la Provencale*, Fricandeau of cod, cod served with butter, and cod's head and shoulders, also steaks in batter, grilled, devilled.

DAB

(*Pleuronectes limanda*)

Very common, light brown flatfish of sea and estuaries. Dark spots and round, spiny scales right side uppermost. Outline like a small plaice with no red spots. Grows to 9in. and over 2lb. (I.O.W.). In season most of year according to district, best in winter. Nut-like flavour. Fried, steamed.

DOG-FISH
(*Scyllium catulus*)

"Large Spotted Dogfish," "Bull Huss." One of the smaller sharks common off-shore and estuaries, living near bottom. Long grey-spotted body, broad, rather flat head, rounded snout, small pointed teeth. Active at night and predatory, taking bait off lines and captured fish, also feeds on shellfish. Grows to 21lb. and 4-5ft. Often bites fishermen when in nets. Palatable food; boneless (gristle), sold in fish shops as "flake." Caught Scottish sea lochs and around coast most of year, especially winter. Dried for winter food in Orkney. Best fried. Also fished for liver oil and skin (shagreen). See illustration on page 115.

The Small Spotted Dogfish (S. canicula) or "Rough Hound" grows to 3ft. and has grey-fawn body banded and spotted with dark brown and black, but is not often eaten for food, usually taken for oil or shagreen. Spur Dogfish (Squalas acantha), with sharp poisonous spines before each of its two dorsal fins; grows to 4ft. It is a N. Atlantic fish visiting British coasts and destroying fish catches in nets. Head, skin and fins are removed and then sold on market as "flake." Nutritious but not much esteemed as food. Has been used by German and other Continental canners to produce an imitation "smoked salmon."

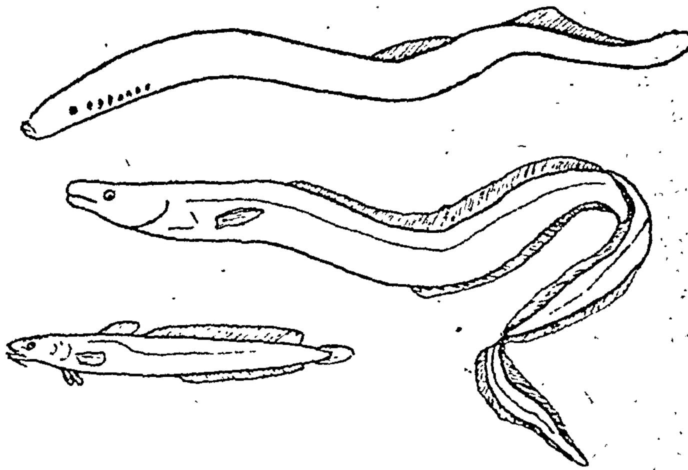
EEL (*Freshwater*)
(*Anguilla vulgaris*)

Long, narrow, round-bodied fish hatched in Sargasso Sea of W. Atlantic, which migrates to rivers of America and Europe, in young or elver state, which ascends rivers, crossing meadows on damp dewy nights to live in ponds and lakes (even Welsh tarns 1,000 ft. above sea level) until mature, when returns down river to sea to spawn again in Sargasso sea and die. Small scales embedded in skin; tail surrounded by the median fin. Grows to 3ft. and 9lb. or more. Small elvers netted ascending rivers on tides in spring (April), and female silver eels trapped descending rivers in summer and autumn. They ascend day and night according to tide (2,000 elvers to the pound). Largest catches of old eels early October, especially Norfolk Broads and Cheshire meres. Even ascend rivers of Syria in E. Mediterranean, India, etc. Male eels generally live in or near estuaries, and majority of silver and yellow eels are female. Rarely caught at sea, often in estuaries. Holland, Germany, Denmark, Italy (R. Po.), Ireland (R. Bann) have big exporting eel-fisheries, and eels are occasionally fattened in muddy waters, e.g., in Italy. One of the richest of fish foods; in season all the year; highest nutritional value of British freshwater and sea fish and best in the autumn. Record freshwater eel from New Zealand weighed 62½lb. and 5ft. 2in. long with 22in. girth. Should be eaten fresh, after soaking in salt water and skinned. Baked, boiled, fried, jellied.

CONGER EEL.

(*Conger vulgaris*)

Gigantic, scaleless marine eel, with deeply cleft mouth and sharp cutting edge to row of teeth. Large eyes and gill openings, upper jaw a snout, back fin commences close behind head. Very strong fighter, haunting deep water and rocky coasts. Female larger sex, grows to 8ft. and 128lb.; male much smaller, with blunter snout and larger eyes. Feeds on herring and mackerel at night and spawns in deep Atlantic. Roe weighs up to



Top—**Lamprey** (see page 104); Centre—**Conger Eel**; Bottom—**Ling** (see page 105)

15¼lb. Caught in N. and S. Atlantic. Season, Nov.-Aug. Should be hung to dry, as in I.O.M. Flesh highly gelatinous and dried and grated to thicken soup. Basis of turtle soup. Can be baked in slow oven for two hours, rolled in flour and wrapped in bay leaf, and flavoured with onion. Conger-pie with chopped parsley, egg, milk, flour, salt and pepper, and flaked pastry crust; the fish is washed dry and cut into squares, the whole baked in hot oven for 20 minutes.

FLOUNDER

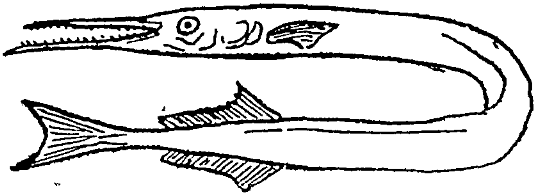
(*Pleuronectes flesus*)

"Fluke." Greyish-brown flat-fish, right side up darker or mottled. Small smooth scales, some projecting larger scales forming rough spiny knobs along base of fins. Sharp, chisel-like teeth for cutting food. One of commonest estuary "flats," ascends to live in freshwater buried in mud or sand as much as 20 miles or more up river, but returns to spawn offshore. Usually in brackish water. In season all the year, and weighs up to 4½lb. Usually too small to fillet: steamed and fried whole, or boiled like plaice.

GARFISH

(*Rhamphistoma belone*)

Extraordinarily active fish which comes to coast with mackerel shoals in summer; a southern fish visiting North Europe and ranging from the Mediterranean to Iceland. Adult has long slender beak of projecting jaws, but young with normal jaws.



Shoals skim along at surface with undulating motion and often leap. Has green bones. Grows to 6ft.; in season, March-April. Wholesome, well-flavoured. Broiled, fried or boiled and eaten with shrimp sauce; best cut into pieces and soaked with vinegar, wine or oil and any flavouring for 1-2 hours.

GRAYLING

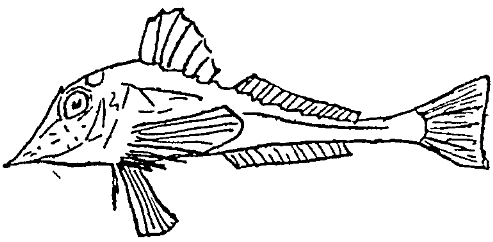
(*Thymallus vulgaris*)

Salmonid, with lattice-like scaling, inhabiting swift rivers of N. Pennines and W. Britain (not Ireland); Europe from Sweden and Lapland, Italy and Russia; also N. America. Partial to clear running water. Has long back fin, small mouth, fatty or adipose fin above tail. Weighs up to 4½lb. in England and 5lb. Scandinavia. In season, Aug.-Dec. Cucumber flavour. Baked, fried or broiled as with whiting.

GURNARD

(*Trigla hirundo*)

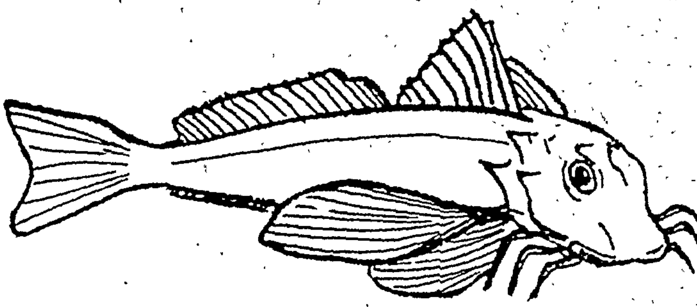
"Yellow" or "Sapphirine Gurnard," "Gurnet." One of the most brilliant of British inshore sea fish with sapphire-blue edges to large, spreading breast fins, brownish-red body with red-purple back and tail fins. Grows to 2ft. long and 14lb. weight.



Most esteemed of the gurnards; in season all the year, best Feb.-Sept. Caught Irish Sea, Shetlands. Firm flesh, flavour near to turbot. Baked and stuffed with parsley, butter and bread crumbs, hot or cold. Small fish skinned and fried. Pale orange-pink

flesh, firm and flaky. Gurnet Hot Pot; filleted gurnet and spaghetti.

Gurnards have large angular head, armoured with bony plates, and three long, finger-like walking rays from breast fin on each side of shoulder, used to run along bottom when walking or feeding on shrimps, crabs and small fish. The Grey Gurnard (*Trigla gurnardus*) in season all the year, also has a red variety,



and there is the Red Gurnard (*T. cuculus*) or "Cuckoo Gurnard," *smaller than the common gurnard, growing to* $\frac{3}{4}$*lb. and 12-14in.* in length. When fresh this is bright red with silvery sides and belly, and reddish fins, but also occasional brown variety. Pinkish flesh, good flavour but rather dry. Cooked as haddock.

GWYNIARD

(*Coregonus pennanti*)

Small salmonid or whitefish inhabiting Lake Bala, Wales. One of the so-called "freshwater herrings," like the Powan, Vendace and Pollan. Large eye, silvery body, adipose fin; grows to 16in. Netted occasionally and potted, or sold locally.

HADDOCK

(*Gadus aeglefinus*)

One of cod tribe, with black patch on each side of body above pectoral fins and black lateral line on body finishing above pectorals. In large shoals in Atlantic and off British shores. Weighs up to 8lb. (Ireland) and grows to 3ft.; largest in northern and winter spawning shoals. In season, winter, locally; but caught all the year in trawls in North Sea, Newfoundland Banks, Iceland, Faroes, Barents and White Seas, Shetland, Orkney and West Scotland. Split, dried and smoked. Also cheese haddock made with egg, lemon-juice, breadcrumbs and sauce. Fine flavour. Boiled, baked, broiled, stuffed, fried, savoury-baked haddock garnished with mashed potato and stuffed.

NORWAY HADDOCK

(*Sebastes norvegicus*)

A vivid scarlet northern perch, not a true haddock, large shoals of which are winter visitors to the rocky grounds of Scotland. Also trawled Iceland and landed mainly at Aberdeen and Grimsby. Viviparous. Grows to 3ft. long. Tasty, nutritious flesh. Baked, fried. Also called the "Berghilt."

HAKE

(Merluccius vulgaris)

Atlantic deep-water member of the cod tribe, 50-200 fathoms. Has two back fins, one anal, no barbel or feeler. Well developed pelvic fins; plainly visible lateral line along side of body ending above pectorals. Predatory on herrings and pilchards in Summer in North Sea. Grows up to 20lb. and 4ft. Trawled day-time and with hooks or trammel net and surface-netting at night. Devon, Cornwall, Newfoundland Banks, S. Ireland, W. Scotland, Spain, Morocco, North Sea, Biscay and landed mainly at Fleetwood, Milford Haven, Cardiff and Swansea. Ranges Faroes-Biscay, spawning Continental shelf, also parts of North Sea and the Skagerack. In season all the year, best Sept.-April. More delicate taste than cod. Baked or boiled, steaks with mushroom and garnished with lemon.

HALIBUT

(Hippoglossus vulgaris)

Largest of the flatfish, with thick narrow body, wide mouth, smooth scales; dark olive above, pearly white below. Predatory, voracious feeder on fish in northern cold waters, rarely taken in-shore. Haunts rocky ground and unlike other "flats" equally well captured by trawl or line. Right side up. Grows to 320lb. and 7½ft. (I.O.M.), 456lb. and 8ft. 1in. x 3ft. 11in. (Iceland). Trawled S. Ireland, Newfoundland Banks, Iceland, Faroes, Pacific, Kamchatcka, California, Greenland, Barents Sea, Bear Island, Spitzbergen, Rockall. Landed at Hull and Grimsby. A coarse flesh but wholesome if in fresh steaks or cutlets, boiled, baked, fried or grilled. Sauce makes up for lack of taste. In season all the year. Also fished for liver oil; richer in vitamin A and D than cod liver oil. Halibut scollops coated with egg and breadcrumbs and fried. Baked in tomato, or brown sauce, cheese or shrimp sauce; fried steaks served with lemon, grilled.

HERRING

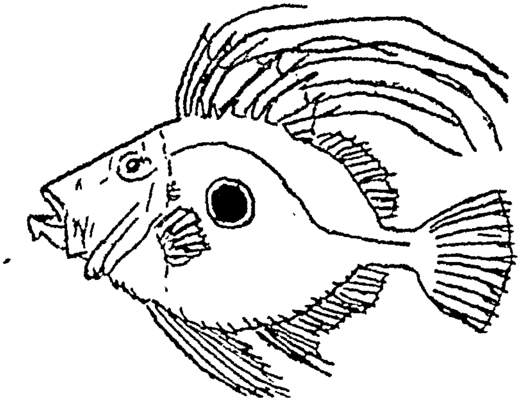
(Clupea harengus)

The Atlantic herring appears in nocturnal shoals migrating against the currents, and is caught in drift nets. The North Sea migration is at Norway in March, the Scottish season is June-August, the Yorkshire or Yarmouth season September and English Channel December. Caught in purse-seine in Scottish sea-lochs and Scandinavian fjords. Loch Fyne. Caught North Sea (Dogger Bank), E. Britain, W. Irish Sea, Scandinavia, Isle of Man, Lofoton Isles, Baltic and E. Canada. Centres: Stornaway, Peterhead, Fraserborough, Yarmouth, Lowestoft, Boulogne, and (1947) Holyhead. Grows to 2½lb. and 2ft. 6in. (Berwickshire). Silvery fish with deeply forked tail and hind part of body serrated. In season all year, especially May-February. Smoked kippers and bloaters, red herring, pickled, salted, baked, broiled, stuffed and canned (Canada and Ireland). Also used for fish-oil.

JOHN DORY

(Zeus faber)

A very thin, golden-yellow fish with deep body, large mouth which opens by curious sliding movement of upper jaw, protruding it like a tube, shooting out mouth to engulf prey which is stalked by slow swimming, using fins as propellers, and thin



body escaping detection. Brilliant eyes move independently. Long, stout spines in back fin, black spot on side of body. Grows to 8½lb. (Cornwall). Caught in seines when netting herrings and pilchards. Valued by epicures if fresh and thick. Boiled and served with butter or soft sauce. In season all year, but best January-March.

KIPPER

Split Herring, dried, salted or smoked, *q.v.*; also Haddock or Salmon split open; male Salmon.

LAMPREY

(Petromyzon fluviatilis)

"River Lamprey." Primitive, naked eel-like fish with 7 gill-holes and a sucker mouth. Often attached to sharks, salmon, tunny, etc. Caught in large numbers when ascending rivers to spawn. Young has single median fin, divided in adult which also has eyes and horny teeth in the sucker. Hindermost dorsal fin continuous with anal. Adheres sucker to stones in rivers, and in Welsh Dee, etc., wooden tongs used for removing lampreys from stones. Grows to 3lb. and 2ft. long. Caught Severn February-May, Continental rivers June August.

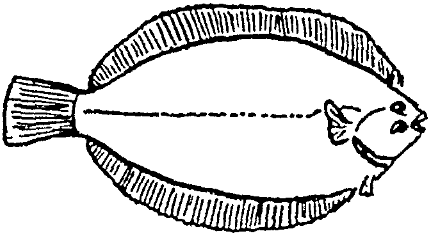
One receipe for potting: scald, scrape, clean, season and bake in slow oven in gravy and cover with clarified butter. Large lampreys should be put fresh in boiling water, then scraped clean, clean entrails, dry in cloth, rub in pepper and salt, and bake in a quick oven with butter for 3 or 4 hours, then add more butter before cooling. Also roasted, or boiled tender with

salt, pepper and onions for $\frac{1}{2}$-$\frac{3}{4}$ hours and served hot with butter. Henry I died of surfeit of lampreys!

The sea-lamprey (*P. marinus*) growing to 31in. is probably only a variation of the river-lamprey, like sea-trout and brook-trout varieties. Occurs Atlantic to West Africa.

LEMON SOLE
(*Pleuronectes microcephalus*)

An oval relative of the Dab with small head and mouth and large, prominent eyes, twisting chameleon-like independent of each other. Bright, brownish-yellow, clouded and blotched with dull yellow and brown. Feeds on crabs and worms. Has small, smooth scales, right side uppermost. Smaller mouth and thicker



lips than a plaice; not a true sole. Grows to 17in. and generally caught North Sea, Iceland and Faroes. In season, June-October. Very nice, and a more delicate taste than plaice; fried, steamed etc., like plaice. Not so good as true soles. Lemon Sole au Gratin, with sherry or milk.

LING
(*Molva vulgaris*)

A long-bodied northern member of the cod tribe, a deep water fish growing to 3ft. and 45lb. (Cornwall) and 4ft. and 70lb. Marine relative of Burbot, but with several large teeth in lower jaw. Two back fins and one anal fin like Hake, but much longer in body, and has feeler below chin. Greyish-olive with silvery belly, fins edged with white; rounded tail fin and large mouth. Rivals cod-fishery, and many caught by line or trawl, Shetland, Orkney, Greenland, Iceland, etc. Split, cured and dried as stock-fish. Liver yields oil formerly used for lamps in Shetland and air-bladders ("sounds"), like those of cod are pickled. In season September-April. Fillets creamed with cheese sauce, steamed, baked with tomatoes, fried, stewed with spring onions and mashed potatoes, garnished with hard-boiled egg. Curried as fried croutes.

MACKEREL
(*Scomber scombrus*)

A beautiful, warm-blooded surface-feeding fish, swift and active, visiting coasts in summer shoals, large fish near the bot-

tom, pursues herring shoals. Greenish-blue back with wavy black cross-bands; silvery belly tinted pink, blue and pale green. 5-6 finlets behind back fin and two ridges on each side of tail. Grows to $4\frac{1}{2}$lb. and 2ft. by $1\frac{1}{2}$ins. (Cornwall). Surface feeding shoals feed on minute food day and night, migratory, warmer blooded than most fish and has redder muscles. Common Mediterranean, East Atlantic, Cornwall, Devon, ranging from Canaries—W. Scotland, N. Sea and W. Atlantic (Cape Hatteras, Labrador). Caught in drift-nets May-July. Occasionally trawled in N. Sea during winter, when retires to deeper water. At S.W. coasts mainly May-August when migrates shorewards. Big fisheries also Massachusettes and Maine, Gulf of St. Lawrence. In season all year, especially April-November. Very tasty but rapidly taints and loses flavour if kept unpreserved, and may become poisonous if stale, and less digestible than white fish for sensitive stomachs. Boiled, baked, and Mackerel à la Maitre D'Hôtel (broiled, with a little salt, cayenne and clarified butter inserted, until brown, and served hot decorated with water-cress).

HORSE-MACKEREL

(*Trachurus trachurus*)

"Scad." A handsome winter visitor to coasts, not near related to common Mackerel. A row of keeled shields along each side of body. Swims in shoals near surface feeding on fish fry in winter and spring, coming inshore but retiring to deeper water in cold weather. Body more or less compressed, small scales. Grows to $3\frac{1}{4}$lb., 18in. Young canned in oil like sardines by Portuguese, mainly exported to South America. Adult of poor food value.

MEGRIM

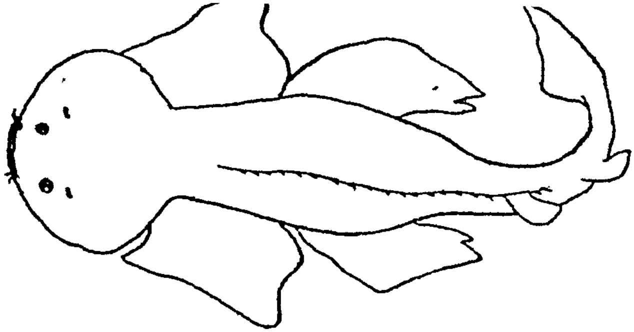
(*Arnoglossus laterna*)

"Scald Fish." Thicker than a Witch, occasionally seen in fish shops. Like a sole but larger and thinner in size, mouth on the left side. Mostly eaten in Midlands, cut across fillets for frying slowly in dripping until tender and sprinkled with vinegar or lemon and finely chopped parsley. Baked for 15 minutes in hot oven in seasoned flour, sprinkled with ketchup and served with hot potato crisps garnished with lemon and capers.

MONKFISH

(*Rhina squatina*)

One of the shark tribe, named from cowl-shaped head, also called "Angel Fish" from very large, wing-like breast fins. Broad, flattened body like rays. Lies on bottom of sea to catch passing fish and varies colour according to ground. Swims with undulating tail. Chocolate brown colour, white below, produces living young. Has been found to swallow gulls, shags and cormorants.



Grows to 6-8ft. and 36lb. (Herne Bay). A voracious ground feeder on flat fish, shell fish. Also caught Scotland. Skinned and cleaned, tastes like sweet Hake and used for fish-pie. Baked monk fish with fried apples or tomatoes and onions. Grilled with mustard and capers.

MOON FISH

(*Lampris luna*)

"Opah." Beautiful deep, short-bodied fish. Comes from open sea in the warm Atlantic and Pacific. Swims near surface, has small, toothless mouth; grows to 4ft. Bluish body with round silver spots and reddish fins. Rich delicate flavour to flesh.

GREY MULLET

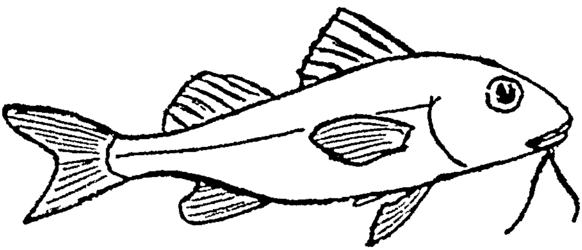
(*Mugil capito*)

Active summer visitor, amongst few vegetarian sea-fish, shoals coming inshore and entering estuaries with the tide. Often springs out of the net. Silvery blue-grey above, white below, with dusky bluish stripes along length of body. Small mouth with small weak teeth, no lateral line, with 4 stiff spines in first back fin; has strong bird-like gizzard to stomach. Thick lipped and thin-lipped varieties. Sometimes fattened in fish ponds abroad. Grows to 8¾lb. (Portland), to 18lb. abroad. In season July-Oct. Boiled, baked, broiled or cooked like Red Mullet and Whiting, and big fish cooked like Cod or Salmon. Not such fine taste as Red Mullet.

RED MULLET

(*Mullus surmulletus*)

Brilliant red summer fish caught off rocks S.W. England and Wales, occasionally ranging north to Scandinavia. Big-

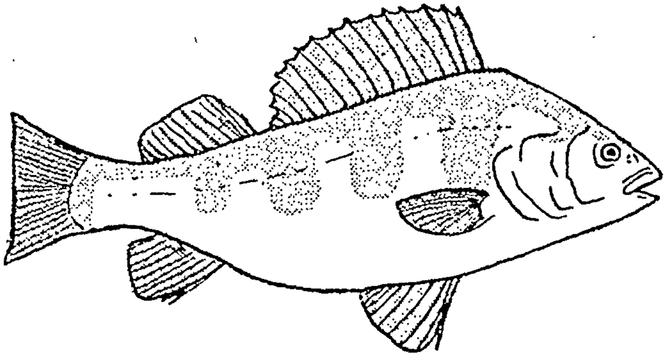


headed and nearer relative of Sea-Breams than Grey Mullet. Two stiff barbels on lower jaw used to stir up sand for shrimps, worms, etc., and folded back when not in use. Two short back fins. Females with 3 or 4 yellowish stripes along body. Grows to 15 ins. (average 6 ins.), and 2 or 3lb. Famed for distinctive delicate flavour, much better than Grey Mullet; very red and short and firm to touch. Must be cleaned carefully, lightly scraped, gills pulled out, but liver left in fish as valued as a great delicacy. Baked or grilled but should not be boiled. Broiled in oiled paper over a slow fire and served hot with mushroom or fine sauce. Baked in moderate oven 15-20 mins. and served with claret, mushrooms, onions and parsley.

PERCH

(*Perca fluviatilis*)

Common freshwater fish in lakes and ponds, still waters, preying upon others and cannibalistic. Dark transverse bars mark body; spiny back fin. In season July-February. Young perch from Windermere etc. canned in tomato sauce and York-



shore relish during war as "Perchines," but very bony. Grows to 5¼lb. Fresh perch very pleasing flavour; should be skinned and fried whole after scales are scraped off, or grilled, boiled, stewed or cooked au court Bouillon with small onion, herbs and white wine.

PIKE

(*Esox lucius*)

Common freshwater fish in European rivers and lakes. Long, grey body, long jaws, voracious and carnivorous; grows to 37½lb. (Hants. Avon) and much heavier on Continent. Ranges to Lapland and Siberia. In season Sept.-March, especially winter. Baked with anchovy or tomato sauce, or stewed or casseroled with white wine and bacon. Dry fish, requiring good sauce and unwholesome roe should be removed. Can be roasted or boiled but much depends upon the dressing. Uneatable just after spring spawning. Fillets fried in sweet oil, stuffed with forcemeat of egg yolk, anchovy, biscuit, bread crumbs, parsley, onion, mace, black pepper, salt, etc. and baked and basted with

butter and served with anchovy sauce (Scotland). Boiled then cooled and broken into flakes and fried with butter, pepper and salt and dressed with oatmeal or flour. Thick fillets sprinkled with chopped truffles, cooked and eaten with white wine and oysters. First soak in brine then bake with bacon and garnish with tomatoes and chopped olive. Smoked like haddock and fried. Quenelles de brochet, stuffed with lobster meat and truffles and cooked and served with lobster sauce.

PILCHARD

(*Sardina pilchardus*)

"Sardine," "Bristling" etc. Small southern relative of Herring, especially caught near Portugal, Spain, France, Atlantic coast, Madeira, Cornwall, Southern Ireland. A variety ("sardina") caught in Mediterranean. Occasionally with herrings off Yorkshire coast. A surface-feeder caught with drift nets and seine nets, summer and autumn. In season Nov.-March. Usually canned in olive oil and tomato sauce. Sardines are young pilchards caught and canned in Portugal, Biscay, Pacific, etc.

PLAICE

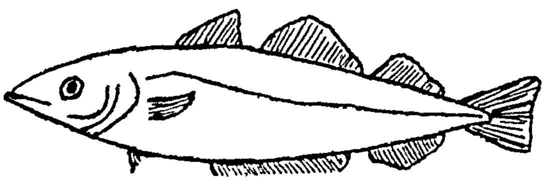
(*Pleuronectes platessa*).

Rich brown flat fish with darker markings and orange-red spots, ringed with paler colour in old fish and darkened in stale fish. Right side uppermost. Big knobs on head, large eyes, straight flat teeth for crushing shell fish and small crabs. Common off sandy and shallow coasts. In season all year round, grows to 7lb. (Hastings) and 23ins. by 13ins. Best May-January. Caught Iceland, Faroes, Barents and White Sea, France as well as British coast. Not so tasty as sole. Boiled (simmer for 6 or 7 mins., but not too long or it breaks) and served with melted butter, parsley, shrimp or anchovy sauce. Plaice and mushroom hot-pot; stuffed plaice with chopped suet, parsley, milk, nutmeg, browned bread crumbs, etc.

POLLACK

(*Gadus pollachius*).

Southern relative of Cod, haunting rocky sea Norway-Mediterranean, including Western Britain, growing to 21lb. (Land's End) and 18ins. to 3ft. Lower jaw longer than upper,



no barbel, dull green above, lighter below. Dotted lateral line curves up steeply over pectoral fin. Feeds on fish in mid-water, very confiding and taught to feed from hand in aquarium. Caught by surface fishing, and mainly Newfoundland Banks, and Western Britian to Shetlands. Roasted or baked like Bream with bacon fat, egg, chopped parsley, bread crumb stuffing, well basted with dripping for 30-45 mins. and served with anchovy sauce.

POLLAN

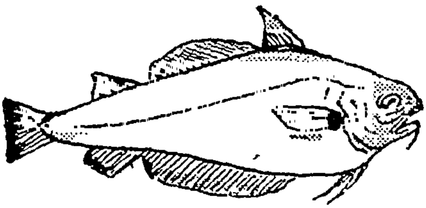
(*Coregonus pollan*).

Small salmonid or "whitefish" netted Lough Neagh and Loch Erne, Ireland, occasionally Loughs Derg and Ree, where shoal in numbers like Powan and Vendace. Grows to 2lb. Potted or eaten like charr.

POUTING

(*Gadus luscus*).

"Bib." Small member of Cod tribe, of deep copper colour; hides in rocks by day and active at night. Searches for food



in sand and mud with the sensitive barbel on its chin. Grows to a foot long and 4¾lb. (Cornwall), and makes good eating, but the flesh decomposes rapidly if not fresh. Cook like Pollack.

POWAN

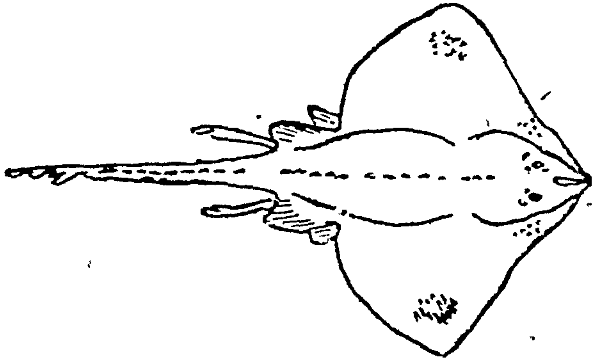
(*Coregonus clupeoides*).

Small whitefish like Pollan, shoaling in Lochs Lomond and Eck in Scotland where netted on large scale with seine nets, and Lomond fish find ready sale because of high food value. Grows to a foot long and cooked like charr.

RAY

(*Raia clavata*).

"Thornback Ray." Commonest ray, in shallower water than others, brown with light spots above and white below. Flattened from above downwards, not sideway like most flat-fish; breast fins of great size, long whip-like tail. Lies on bottom of sea. Large respiratory spiracles on head behind eyes. Swims by wave-like movements of body, rising over victim and pinning it down to devour it. Eggs known as "mermaid's purses" (also



those of Skate and Dogfish). A rough skin with several large curved spines and a prominent one down the back to the end of the tail. Male has pointed teeth, female flat teeth. Grows to 60 lb. and 3ft., feeding on flatfish, eels, herring, shell fish, etc. In season most of the year, best in winter. Cook like skate and serve with hot butter. The Blonde Ray (Raia brachyura) of S.W. England, growing to 4ft., is also used for food.

SAITHE

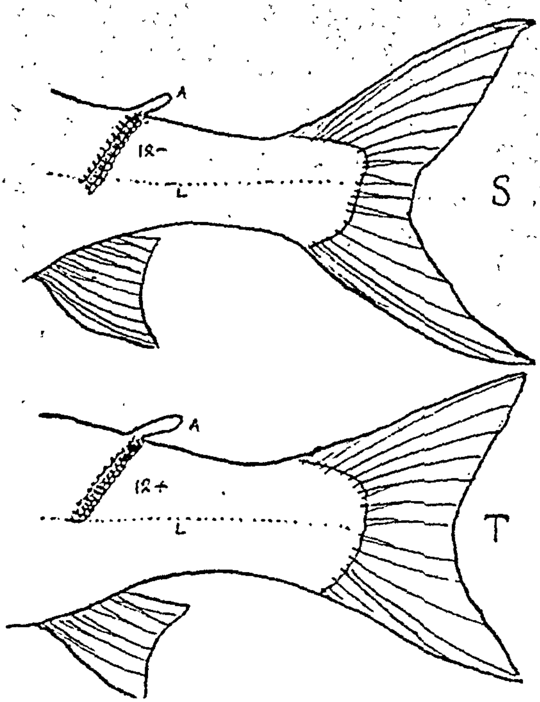
(Gadus virens).

"Coalfish," "Billet." A large northern fish like a Pollack, called "Coalfish" from its frequent black colour; usually darker and lower jaw does not project as in Pollack. Silvery white lateral line along side of body. Large fish are found amongst rocks, smaller fish in shoals, a timid fish, it has a small barbel and is caught mainly off the Clyde and Scottish Isles, growing to 23½lb. and 3½ft. long. Less edible than the Pollack, and of cod flavour, it is best fried. Chopped and baked like Ling or Hake with hard-boiled egg, etc., to make pasties with short pastry. In season in Winter.

SALMON

(Salmo salar).

The Atlantic salmon, famous for its journey from the rivers of birth down to feed and mature in some common consorting-ground deep in the North Atlantic (save for Swedish salmon which travel to southern Baltic Sea) and returning to river of birth, is netted in the estuaries of swift rivers of the British Isles, Scandinavia, East to the Petchora river and South to the Loire, and in Eastern N. America. Most reliable distinction from Trout is that it is has 12 or less scales side by side from fatty or adipose fin (between back fin and tail) and the lateral line, the Trout having more. Grows to 103lb. (Forth), very firm, dry, nutritious



S.—Salmon; T.—Trout (see page 116)

red meat. British salmon in season Feb-August; Dutch and Canadian all year. Boiled, broiled, fricasseed, pickled, Salmon souffle, pudding, a la Maitre D'Hotel, au Blue, Cutlets, etc.

The Pacific salmon (Oncorhynchus sp.) well-known as American canned salmon are of five different species. Those exported to Britain are mainly "herka" ("Sockeye"), "tachawyischa" ("Quinnat" or "Chinook") and "gorbuscha" ("pink" canned). They range from California to Alaska, Japan, Siberia and China, and most exports come from British Columbia and Alaska.

SARDINE (See Pilchard).

SHAD

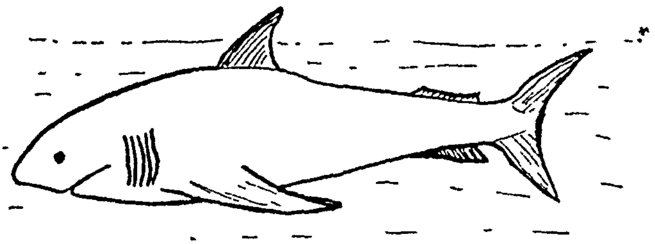
(*Clupea finta*).

"Twaite Shad," "King of the Herrings." A beautiful big herring, silvery with dark spots, which migrates into estuaries and is occasionally caught in trawls in North Sea. Grows to 13ins. It has larger gill-rakers than the Allis Shad (Clupea alosa) a very active and lively relative, with black blotches on its silvery sides, which also ascends European rivers and the Nile. This grows to 3lb. In season summer; cooked like herring.

BASKING SHARK.

(*Cetorhinus (Selache) maximus*)

" Herring-Hog." A large harmless shark, common off west coasts of Britain, named from basking at surface in calm sea in summer, with large back fin exposed. Known from whale by five long gill-slits in neck, and vertical tail, but these are often con-



fused. Mouth with round, knob-like teeth, feeds on small crustaceans strained from the water by its long gill-rakers. Grows to 40ft. and fished for liver-oil in western Ireland and W. Scotland. Can be eaten like dog-fish in batter or casseroled, but not very attractive.

SKATE

(*Raia batis*)

" Roker." Long-snouted ray, very voracious amongst other fish and shell-fish, coloured greyish-white with black spots. Grows to 336lb. (Devon); in season October-August. Usually steamed with tomato sauce. Generally sold cut in pieces or crimped. A nourishing food to be eaten fresh, first skinned and steeped an hour in cold water. Boiled with black butter 15-20 mins. and a little vinegar added to the water. Skate au Gratin fried slowly with salt, vinegar and margarine, seasoned with salt and pepper then baked for ten minutes with gravy and sprinkling of cheese, in hot oven or under grill until cheese browns.

SMELT

(*Osmerus eperlanus*)

"Sparling." A beautiful little salmonid, like a whitefish, swimming in an undulating course and often entering estuaries, North Europe. A delicate flavour like violet or syringa perfume, in season Sept.-May. Grows to 8ins. Should be washed only with little water and wiped and dried carefully. Pull gills and entrails out and fry with a little flour, egg and bread crumbs in fat and serve with anchovy or shrimp sauce. Smelts *en Matelote* cooked gently with onion, lemon, mushroom and served with sherry or champagne over them.

SNOEK

(Sphyraena sp).

South African Barracuda, sold canned in Britain. Grows to 18lb. and 4ft., steely bluish-black above and silvery below. Very small, thin scales. Related to Grey Mullet, but looks like giant mackerel with pike-like mouth of dangerous teeth. Ferocious and bites fishermen, but extensively caught for food, from Mossamedes on West coast round the Cape as far as Algoa Bay on East. Season according to locality, August-Sept. in first-named place May-July in last-named. Canned snoek has some similarity to tunny. Caught by trolling from rowing boat. Eight ounce halves are canned in tomato sauce and exported from S. Africa. Also used for Gesmoorde Snoek, fish kedgeree, shredded with rice. Eaten hot with potatoes or cold with salad.

SOLE

(Solea vulgaris).

Yellowish or greenish-brown flatfish with rows of dark blotches down middle of body and near bases of fins; black spots on outer end of breast fin. Nocturnal, hiding in sand by day, moving from rough ground in stormy weather. Right side up. Unlike other flatfish, longer than broad, smaller, less prominent eyes, and more uniform in colour—grey or brown. Mouth at end of nose. Grows to 7ins. (often deformed), and 4lb. (I.O.W.). Not found North of North Sea; often named from locality of capture, e.g., "Dover Sole." Haunts warm, sandy places in Atlantic south of Skagerack. In season all year and valued for delicate flavour. Inferior flavour if with roes, and should be filleted. Fried, Fillets of Sole au Gratin, a l'Horley, a la Mornay, Sole Normandie, Fillets a la Parmentier, Fillets Provencale, Sole a la Rouennaise.

SPRAT

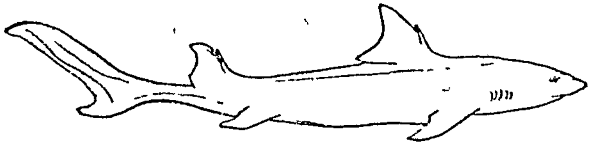
(Clupea sprattus).

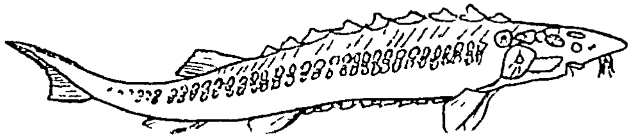
Small relative of the herring, with a more backward position of the back fin, and strongly serrated lower edge of body. Grows to 5in. and confined to area Norway to Black Sea. Caught drift nets and seine nets in North Sea, Norway, Forth, Thames estuary, Channel, Baltic and canned in Norway. In season Oct.-March. Cleanse well and broil brown and serve hot, decorated with lemon, parsley, etc.

STURGEON

(Acipenser sturio).

Long-bodied marine fish ascending rivers of Mediterranean and Black Sea, Caspian and Siberia. A few specimens of the Atlantic Sturgeon are trawled in W. British waters annually and sometimes caught in rivers (460lb. in Esk, 24ft. long in Danube, 3,200lb. Russia), but there are various European species. Specimen 8¾ft. and 15 stone caught off N. Ireland. Has narrow, pointed





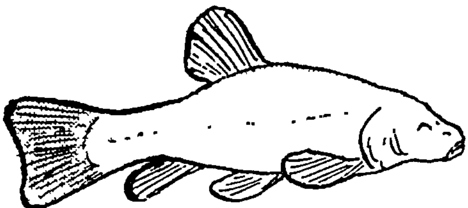
Top—**Spur Dogfish.** Bottom—**Sturgeon.**

snout and bony plates on body. Caught in Volga for roe (salted) and swim-bladder (exported as isinglas); roe used for caviarre in Russia, etc. Average 100lb. fish gives 18-20lb. caviarre; one of 269lb. from Volga gave 49lb. caviarre. Caviarre made at Valcov (Bessarabian Danube), Molossol and Beluga (Caspian). Roe is sieved, washed, salted. Its flesh, like that of the "Sterlet," also good eating. In season Sept.-March.

TENCH

(*Tinca vulgaris*).

Very dark olive-green, slimy, round-finned freshwater fish of still, reedy lakes and ponds, Britain and Europe. Sluggish, nocturnal. Grows to 7lb. (Weston-super-Mare), and more abroad;



sometimes fattened in fish ponds on Continent. In season summer. Needs treating like Carp to get rid of muddy flavour, and cooking fresh; needs filleting as it is very bony, then fried in dripping or butter with a little salt; serve with cut lemon and parsley.

TOPE

(*Eugaleus galeus*)

A large, dark-grey dogfish, dirty white below, with short muzzle and crescent-shaped mouth. An Atlantic fish frequently caught on line in summer, and in trawls. Produces young alive; female grows to 62lb. (Herne Bay) and 6-7ft., male to 49lb. and 6-7ft. (Hastings). Also caught in Thames Estuary, East Coast and Wales. Flesh has rather rank smell, but sold in Lancashire supper bars as "Darwen Salmon." Also fished for skin for shagreen.

TORSK

(Brosmus brosme).

A deep sea relative of Ling, trawled near Iceland, Shetland, Orkney and occasionally in Firth of Forth and other British waters. Has a single long dorsal fin and shorter anal fin, narrow pectorals, and one barbel or feeler on chin. Grows to 20in. Cook like Ling.

TROUT

(Salmo faria).

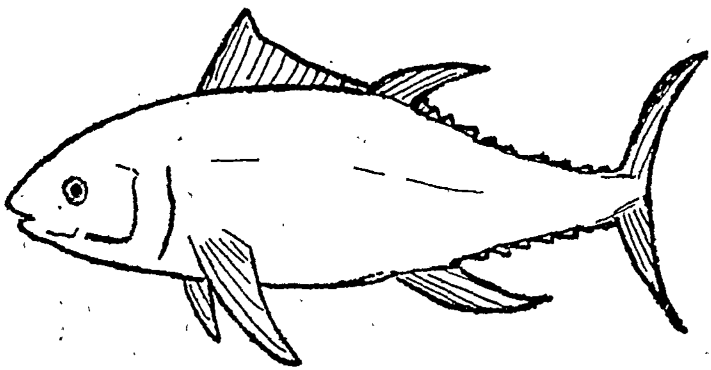
(Illustration on page 112)

A spotted salmonid, with fatty adipose fin between back fin and tail, and distinguished from salmon by possession of 14 or more scales side by side between adipose fin and lateral line, salmon having less. Inhabits rivers and lakes Europe and North America, introduced to New Zealand, etc., and occasionally fattened in ponds. The migratory sea-trout or salmon-trout (herling, "sewin," etc.) and the Loch Lomond Trout (without red spots) are varieties of the same species. Grows to 21lb. and 33in. (Ireland) and heavier abroad, 63lb. and 47½in. (Canada) and 125lb (America). Season (Britain) Feb.-Sept. according to district. Large sea-trout are cooked like salmon; brown brook trout as fresh as possible are boiled, broiled, fried, etc. Trout a la Meuniere. Sometimes trout are as red as salmon in flesh. Hotel sometimes keep live trout in aquaria to assure fresh supplies. Farmed for export in Denmark.

TUNNY

(Thunnus thynnus)

A large mackerel visiting European waters in summer and growing to 850lb and 10ft long, up to 1,000lb. abroad. Has 6-9 finlets between back fin and tail, and single ridge on each side of tail. Caught off Yorkshire coast, Whitby and Scarborough, July-September, off Cornwall October, off Norway July. Red beef-like flesh, canned in America, (California and Nova Scotia). Important fisheries in Nova Scotia, Bay of Biscay and off Tunisia. The fish beheaded and gutted, has to be hung for blood to drain off, and salted to rid it of its strongly tasting natural oils, by



steaming for several hours during which it shrinks considerably. Olive oil is added to avoid dryness. Fresh tunny so treated is steamed quickly to avoid dryness. Tunny liver oil is about 200 times as rich as cod liver oil in vitamin A, and that from the guts 20 times as strong. Small Danish post-war fishery.

TURBOT

(*Scopthalmus maximus*)

Rhomboid shaped flatfish, left side uppermost, which feeds on other fish after hiding, resting partly covered on sandy bottom. Caught in shallow water trawls. Has a sandy-brown speckled body, with a few scattered tubercules. Male grows to 26ins. and female to 36ins. and $27\frac{3}{4}$lb. (Devon). A North Atlanic fish caught off Devon, and other coasts, smaller off-shore and not found north of North Sea. In season all year and of excellent flavour, traditionally finest of the flatfish, with firm, stiff, thick flesh. Boil after removing slime with salt water, and cutting back to bone to prevent white belly from cracking Fins should be left on, as considered a delicacy. Also baked, and filleted

VENDACE

(*Coregonus vandesus*).

Small "whitefish" or Salmonid netted at Lochmaben, Scotland, and Derwentwater and Bassenthwaite in Lakeland. Shoals netted in small sweep-nets. Grows to 9in.; cooked like charr.

WHITEBAIT

(*Clupea sp.*).

Like Sardines, Bristling, etc., a trade name that does not cover a particular species of fish but in this case describes young Herrings and Sprats drifted by the currents into Estuaries and netted—Thamesmouth (Leigh fishery), Norwegian fjords, Northumberland, Morecambe Bay, etc. Potted at Leigh-on-Sea and canned at Stavanger (Norway). In season October-August. Eaten like small sardines, and very nutritious. Fried in flour and lard for 2 minutes, shaking frying basket, and served hot.

WHITING

(*Gadus merlangus*).

One of the cod tribe, with only a minute barbel and does not feed so close to the bottom of the sea as a cod. Feeds on shrimps and fish, and winter visitor to several estuaries. Greenish-grey or yellowish on back, silver belly and yellow lines on sides; a black spot at the root of breast fin. Grows to 21in. and 6lb. (Cornwall). Shoals close to bottom and moves shorewards during night and enters sea-lochs. Caught Isle of Arran ("Whiting Bay"), West of Scotland, Clyde, Lerwick, etc. Season May-Feb. More insipid, wet and bony than other cods, but easily digested by invalids. Fried, boneless fillets; stuffed with egg, lemon-rind, breadcrumbs, mixed herbs, etc., and baked in quick oven.

WITCH

(Pleuronectes cynoglossus).

A flatfish of the plaice tribe, trawled in deep waters and sold as "white sole" "Yarmouth soles" and "soles," "plaice" or "fillet of sole." A thick fish, it is boiled or steamed, or baked in a hot oven for 10-15 mins. with butter and lemon. Curried witches slowly simmered and served with rice and lemon.

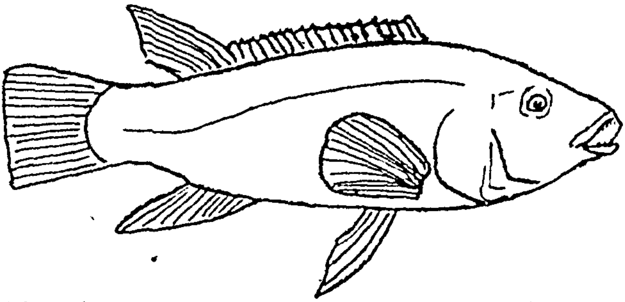
WOLF-FISH

See under Catfish.

WRASSE

(Labrus bergylta).

"Ballan." A heavy, summer, rock-fish brightly coloured with blue, green, yellow, brown and orange, especially in spring-early summer, when spawning. The scale pattern makes a deep reddish network to body, and it has reddish-brown spines and



fin-rays, thick lips and strong crushing teeth in its throat for its greedy, voracious feeding on shell fish and crabs. Has spiny back fins and makes nest of seaweeds amongst rocks. Grows to 12¾lb. (Cornwall) and 1½ft., but smaller in northern waters. Caught mainly West Country and Wales. Its flesh, occasionally eaten, is soft and insipid.

Local Names of Market Fish

Abbot—Monk.
Alewife—Allis Shad.
Angel Shark—Monk.

Ballan Wrasse—Wrasse.
Barse—Perch.
Berghilt—Norway Haddock.
Bib—Pouting.
Billet—Saithe.
Billiard—Saithe.
Bill—Saithe.
Blochan (Eire)—Saithe.
Blockan (Manx)—Saithe.
Black Cod—Saithe.
Bluffin—Saithe.
Black Pollack—Saithe.
Blackjack—Saithe.
Bleck—Saithe.
Black Sole—Common Sole.
Blue Dog—Spur Dogfish.
Bluet—Skate.
Blue Skate—Common Skate.
Blueback—Saithe.
Brett—Brill.
Bronze Carp—Freshwater Carp.
Buddock—Saithe.

Bull Huss—Large Spotted Dogfish.

Caden—Saithe.
Caithnach—Saithe.
Callagh—Pollack.
Carp—True Carp, and Sea-Bream
Carp—Bream—Sea-Bream.
Carter—Megrim.
Catfish—Dogfish (Bristol).
Coalfish—adult Saithe.
Coalman—Saithe.
Coal Whiting—Saithe.
Coalsey—Saithe.
Codling—Young Cod.
Coley—Saithe.
Colmey—Saithe.
Colomie—Saithe.
Cooth—Saithe.
Craig Fluke—Witch.
Cuckoo Gurnard—Red Gurnard.
Cuddie—Saithe.

Darwen Salmon—Tope.
Dargie—Saithe.
Devil Fish—Angler, and Eagle Ray.
Doctor—Tench.
Dover Sole—Common Sole.

Eel-Pout—Burbot.
Elver—young Freshwater eel.

Fay Dog—Lesser Spotted Dogfish.
Fiddle Fish—Monk.
Fishing Frog—Angler.
Flake—Dogfish.
Flapper Skate—Sharp-nosed Ray.
Fluke—Flounder, Plaice.

Gab—Angler.
Garve—Dab.
Garve-Fluke—Dab.
Gar Pike—Garfish.
Gerrock—Saithe.
Gilpin—Saithe.
Glashan—Saithe.
Glass Eel—young freshwater eel.
Glassock—Saithe.
Glissaun—Saithe.
Glossan—Saithe.
Grayford—Saithe.
Greenbone—Garfish.
Green Cod—Saithe.
Green Pollack—Saithe.
Green Tench—Common Tench.
Grilse—Salmon.
Gullfish—Saithe.
Gurnet—Gurnard.

Harbine—Saithe.
Hen Fish—Plaice and Lumpsucker.
Herling—Young Sea Trout.
Herring Hake—Saithe.
Holibut—Halibut.
Huss—Lesser Spotted Dogfish.

Isinglass—Sturgeon.

Jack—Pike.

King Fish—Moon Fish.
King of the Herrings—Shad.
Knowd—Grey Gurnard.
Kuth—Saithe.

Lampern—Lamprey.
Latchet—Yellow Gurnard.
Lemon Dab—Lemon Sole.
Lob—Saithe.
Lob-Keeling—Saithe.
Lucky Sole—Thickback.
Lythe—Pollack.

Maiden Ray—Thornback Ray.
Mackerel Guide—Garfish.
Mary Sole—Lemon Sole.
Maulrush—Saithe.
Merry Sole—Lemon Sole.
Migratory Trout—Sea Trout.
Monk—True Monk, or Angler
Mort—Young sea trout.
Mud Fluke—Flounder.

Nanny Nine Eyes—Sea-Lamprey.
Nurse Hound—Large Spotted Dogfish.

Old Wife—Black Sea-Bream.
Omer—Grayling.
Opah—Moonfish.

Pale Flounder—Witch.
Parr—Young salmon and young saithe.
Parkgate Sole—Common Sole.
Piltock—Saithe.
Plaice-Fluke—Plaice.
Podlie—Saithe.
Pole Dab—Witch.
Poodler—Saithe.
Poodling—Saithe.
Pout—Pouting.
Pride—Young Lamprey.

Rauning Pollack—Saithe.
Ray's Bream—Black Sea Bream.
Red Bream—Sea Bream.
Redfin—Perch and Roach.
River Sole—Common Sole.
Rock Salmon—Catfish, Dogfish, etc.
Roker—Skate.
Rough Hound—Lesser Spotted Dogfish.

Sail Fluke—Megrim.
Saithe—Young Coalfish.
Sand Dab—Dab.
Sand Scar—Catfish.
Salmon-Mort—Sea Trout.
Salmon-Trout—Sea Trout.
Sardine—Pilchard, Sprat.
Scad—Horse-Mackerel.
Scraefish—Saithe.
Sea-Cat—Catfish.
Sea Devil—Angler.
Sea Needle—Garfish.
Sea Perch—Bass.
Sea Pike—Hake.
Sea Trout—Migratory Trout.
Sea-Wolf—Catfish.
Sethe—Saithe.
Sewin—Sea Trout (Wales).
Sey Pollack—Saithe.
Shad—Sprat.
Sillock—Saithe.
Silver Salmon—Angler.
Smear Dab—Lemon Sole.
Snig—Eel.
Soldier—Red Gurnard.
Soil Block—Saithe.
Southport Sole—Common Sole.
Sprag—Cod.
Sparling—Smelt.
Sprod—Young Salmon and Sea Trout.
Sprug—Half-grown Cod.
Stenlock—Saithe.
Sunfish—Opah; Moonfish; Basking Shark.
Suyeen—Saithe.
Sweet Fluke—Lemon Sole.

Thornback Skate—Ray.
Tibre—Saithe.
Torgoch—Welsh Char.
True Sole—Common Sole.
Tub Gurnard—Yellow Gurnard.
Tubbelin Whiting—Cod Bristol.
Tusk—Torsk.

Umber—Grayling.

Whiff—Megrim.
Whitebait—Young Herring, Sprat, etc.
White Cod—Cod.
Whitefish—Powan, Pollan, Gwyniard.
White Fluke—Flounder.
Whiting Pout—Pouting.
White Ray—Sharp Nosed Ray.
Wolf-fish—Catfish.

QUICK-FREEZING AND THE FISHING INDUSTRY

By JOHN L. ROGERS
Consultant in Food Technology

IN order to appreciate the true importance of Quick-Freezing to the Fishing Industry, it is essential to understand just exactly what is meant by Quick-Freezing.

In general, far too many people think of Quick-Freezing as being just another, better, and more rapid method of freezing fish. All the emphasis is put on to the part of the process during which the fish is frozen, rather than on the whole series of events and processes, stretching from the time the fish is caught to the time that it is eaten.

The result of this somewhat restricted view of Quick-Freezing has been that many Trawler owners, wholesale merchants, and the like, have come to look upon Quick-Freezing as a method of preserving cheap glut fish until the market becomes more favourable.

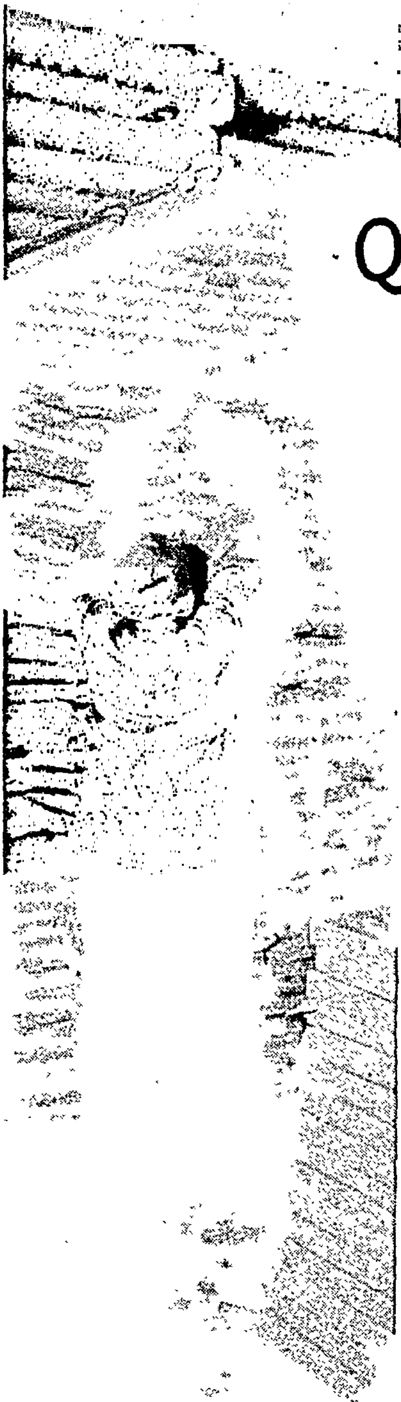
In many cases where Quick-Freezing plants are already operating, the fish, irrespective of its condition—as long as it is reasonably fresh—is simply filleted, sometimes brine dipped, packed into large moulds and Quick-Frozen. It is then stored until market conditions are favourable, when it is issued to Fishmongers and other users who thaw it out and sell it in the same manner as fresh fish, i.e. in the thawed state.

At the present time Government restrictions, the shortage of paper, and many other factors prevent the full-scale development of Quick-Freezing in its wider sense, but in due course this wider aspect must be considered by all concerned.

Besides enabling glut catches to be preserved until such time as there is a shortage of fish on the market, which it must be admitted is an important function of any preservation system such as freezing, the main object must be to present the public with better and fresher fish at reasonable prices.

If Quick-Freezing is to be successful, then it must provide the retail customer with a product at a reasonable price, and of a higher quality than can be obtained by present means.

Now, it will be readily seen that freezing glut or market bought fish in bulk, and then treating it like ordinary wet fish, will not benefit the ultimate consumer in any way at all, other than perhaps making certain kinds of fish available in times of shortage due to



Quick Frozen FISH and LOW TEMPERATURE STORAGE

Whether fish is quick frozen by low temperature air blast as in plant supplied by J. & E. Hall, Ltd., or by some other method, it must after freezing be kept in a low temperature cold store. We are specialists also in the design and equipment of such low temperature stores.

J. & E. HALL
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storms or some other cause. Neither the process or the distribution system have any particular merits.

In order to ensure first of all that Quick-Frozen fish is really first rate, it must be frozen when it is really fresh. This obviously calls for freezing at sea, or at any rate, great care in quality selection at the Ports. After this, the simple act of freezing the fish quickly is not enough. Great care must be taken with the system of processing; special protective packages must be used, and the frozen material must be stored and distributed under carefully controlled conditions. Again, when all this has been attended to, the fish must not be allowed to thaw out and spoil in the fishmonger's shop. It must be kept frozen and in first-class condition, until the housewife actually buys it and cooks it.

More will be said later about the processing and raw material side, but for the moment, it is proposed to deal with matters connected with distribution.

It will be readily appreciated that if a great deal of care and scientific control is to be lavished upon producing a frozen fish product of very high quality, it will be little use putting this into packages which are so large that they must be thawed for separation into small units in the fish shop, where they may be allowed to become stale. Thus, from the outset, it becomes apparent that filleting and weighing into consumer sized units of one pound or less, must be undertaken at the point where the fish is frozen.

Further, it will be seen that if all filleting, wrapping and weighing is to be done at the fish factory, and if the product is to be kept frozen right to the time when the housewife buys it, then the necessity for open fishmarkets, or the fishmonger's slab, as such, virtually disappears.

Not so very long ago, each grocer was a specialist who bought his tea in bulk and did his own blending; who cut his own sugar into cubes; who even boiled his own cocoa beans. To-day, all this has been swept away and groceries are pre-packaged at a central factory and sold as branded units of high quality, over the counters of more and more super-stores. The same tendencies towards pre-processing and packaging may be seen in meat, dairy produce, and most foods, and it does not seem unreasonable to forecast that fish will be treated in the same manner.

In broad outline, the application of Quick-Freezing to fish, means that we shall have large dockside, or floating factories, where fish at its best—right from the sea—will be filleted, processed, and frozen in neat branded packages all ready for Mrs. Housewife to buy.

On the distribution side, all that will be needed will be a refrigerated wagon system, coupled with central distributive cold stores, and shops equipped with up-to-date Frozen Food Storage Cabinets. The fish sold will be branded and guaranteed by the packer, and will be as fresh as when it came from the sea.

It would of course, be foolish to suggest that the new system of handling and marketing fish will ever entirely replace the present system, or that it will become a *fait accompli* overnight, but there is little doubt that the new system will take a very large slice out of the present trade in wet fish.

The advantages of what we may call the Frozen Food method of marketing are very obvious, and may be listed as follows:—

1. The fish will be frozen at its best.

2. Filleting and packaging will be done more cheaply by more automatic means in a factory.

3. Valuable by-products at present lost in a million dustbins, will be collected, all at one place.

4. The whole distributive system is boiled down to the simple handling of "small packages of frozen food,"—as opposed to "fish,"—requiring no special skill.

5. By the use of buffer stores, fish will be made available to all, at any time of the year, irrespective of the weather or other conditions.

6. Last, but by no means least, fish will become a standard packaged article, which can be ADVERTISED on a National scale, at standard year round prices, by well-known packers.

There is no doubt—and this fact cannot be pushed aside—that the development of this new method of marketing will have a very profound effect upon established inland wholesalers and fishmongers alike. The less skill required for the work of handling fish, the more opportunity there will be for the big stores and those who do not normally handle fish, to enter the trade. Those handling such items as Quick-Frozen Fruit or Vegetables, and having equipment for this purpose, will naturally be interested in extending their range to cover fish.

In the same way there will be a natural tendency for the trawler companies who catch the fish, and therefore possess it at a time when it is freshest, to enter the processing side in order to pass their products directly to the markets. This will be especially marked where freezing is to be undertaken at sea.

At the present time, it is naturally difficult, or indeed impossible, to forecast just how the new system will develop in practice, but it would seem that if the established trade is to handle its fair share of Quick-Frozen fish, it must adjust its ideas soon.

The very fact that the wet fish business is not likely to die out overnight, gives the retail fishmonger an opportunity to enter the Quick-Frozen fish business at an advantage. At the same time the very large variety of fish products which is available makes it easier for the fishmonger to retain his position as a specialist.

The fishmonger of the future should, we think, make his shop into what may be called a "Seafood Store," rather than just a

Fish Shop. With suitable and attractive cabinets, he will be able to offer the public a wonderful selection of fish delicacies, not known now. Items such as Frozen Crab or Lobster meat, oysters, cooked fish dishes made by the finest chef, can all be carried in a small cabinet for an almost indefinite storage period without staling or waste. Thus there is no limit to the variety of products which can be stocked, even though the turnover of each is small.

In the same way the wholesaler who equips himself with low temperature cold storage space and sets out to offer a wide range of frozen fish products, will have great scope for new trade among hotels and other users as well as with his retailer clients. Indeed, there seems to be no reason why Quick-Frozen Fruits, Vegetables, Meats, Imported Delicacies, and so on, should not be handled as well. Quite apart from any question of fish distribution there is undoubtedly a great opportunity at the present time, for what may be called "The Frozen Food Wholesaler and Hotel Supplier."

Turning now to the processing side of the business, there is no doubt that the importance of freezing the fish while it is fresh, cannot be over-emphasized. Here, however, it is important to differentiate between apparent and real freshness. Thus, fish which appears by normal standards to be fresh, may not be suitable for making a high-grade frozen product.

Almost as soon as fish is brought from the water, deterioration sets in and whilst this does not make itself apparent in the form of bad fish for some long time, each hour that elapses before the fish is frozen makes it less suitable for the purpose. Even the use of Ice does not prevent the steady spoilage of fish from the freezing point of view, although it does, of course, prevent it appearing to spoil in a general manner.

The reasons for the fact that fish must be frozen as soon after catching as possible, although obvious on the surface are, in fact, extremely complicated and have, therefore, no place in this short article, but it can be said without doubt that the suitability of fish for freezing must be measured against the number of hours out of water, and not by apparent freshness. Every hour, or part of an hour, counts.

From the above, it soon becomes apparent that the only answer to getting really fresh fish will be to freeze at sea. Certainly this is the one and only answer so far as far North fish is concerned. North Sea caught fish may, perhaps, be dealt with on land as it is obviously simpler to do this. In this case, however, the greatest attention must be given to cleanliness aboard ship, preventing the crushing of the fish, which does more to spoil fish for freezing than anything, and to speed of handling at the Port.

The economics of processing and freezing fish at sea are still not very clear but attempts to do this have been made on the Continent in the past, and more lately, in America. There is at least one big new project for freezing at sea going ahead in this country one such scheme involving the use of a new type of trawl.

As has been stated the most impotrant item to be considered in freezing fish is speed, but after this comes proper packaging.

When any perishable food is frozen, whether it be fish or fruit there is a very strong tendency both during the freezing process, and afterwards, in cold store, for the product to lose flavour and weight by evaporation, and by oxidation of the fats present. Thus each pound of fillets must be carefully wrapped in some sort of material which will prevent drying and protect the product against oxidation.

In most cases, pound units of fillets, fish, meat or whatever it may be, are wrapped into moisture-vapour-proof film or waxed paper. The units are then placed into five pound waxed boxes, which are further over-wrapped with heat sealing waxed paper or film. After the whole box has been frozen, the five pound boxes are placed into fluted cardboard cases and sealed with tape.

There are, of course, many different methods of packaging, ranging from small waxed boxes, to close fitting rubber bags, and some processors freeze first and some afterwards, but in every case a high degree of packaging efficiency is essential if a good product is to be made which will survive long term storage.

A number of special processes have been developed for treating the fish prior to wrapping, with a view to preventing drip on thawing and oxidation during storage. Most processors dip their fish for a few seconds into chilled brine, sometimes containing traces of other chemicals. Experiments have recently been made with vacuum treatment of fish.

The actual process of quick-freezing fish is, of course, extremely important, but the full benefits of ultra-rapid freezing against slower methods are only felt when all the other conditions are fully complied with.

There are many different methods of fish freezing, and many hundreds of patents have been taken out during the past 20 years or so. Freezing machines can, however, be classified into three categories:—

(*a*) Immersion Freezers.
(*b*) Contact Freezers.
(*c*) Blast Freezers.

In the early days immersion freezing was used very widely for freezing fish, the principle being to dip fish whole or in fillets, directly into very cold brine where it froze in a very short time.

While this system had the advantage that very intimate contact took place between the fish and the freezing medium, salt penetration into the fish was an almost insuperable difficulty. Many variations of the original direct dip system were tried such as spraying brine, using brine at special eutectic strength, and so on but it can be said that the use of direct immersion has been largely replaced by other methods.

The first contact freezers, in which the fish is frozen by direct

contact with a cold metal surface, consisted of metal pans in which the fish was placed and which were then floated along a river of cold brine. In this case, contact took place from the underside only, and was therefore not entirely satisfactory. From these early contact principles the modern machines such as the Birdseye, Multi-station Froster, and the Jackstone Froster have been developed. There are also a number of machines involving the use of contact from the underside, and cold air blast on the top of the product, but we think that these machines should be more properly classified as blast freezers.

Although contact freezing is now becoming much more widely used, it may be said that blast freezing has been the most popular method up-to-date, as most other systems have been covered by a multitude of patents.

There are many kinds of blast freezers, but in essence these are all the same, consisting of a large box in which the raw material is placed, and a secondary box in which a battery of cooling coils is housed. Air is circulated rapidly over the product and back to the cooling coils in a continuous circuit thus carrying the heat from the raw material to the refrigerant in the coils.

The construction and operation of blast freezers is not a simple matter as special precautions must be taken to ensure that moisture is not carried over from the product to the coils by the air. This means that very low temperatures must be used, and the temperature rise and the air temperature difference between the coil and the air minimised.

All kinds of devices, including special coils, staged air blast, and so on are being used in various proprietary blast tunnels which also include all kinds of mechanical devices for handling raw materials, such as moving belts, mechanical trucks operating in a tunnel, trays moving in a vertical column, and so on.

The important thing to realise is that the food must be frozen quickly and in such a way that minimum dehydration takes place, and also that it must be reduced to the same temperature—all through—as will be used for storage. Thus in a blast tunnel the air temperature may be as low as -30°F.—this low temperature being necessary to prevent drying—but the food will only be reduced to a temperature of -5°F. all through, corresponding to the operating temperature of the cold store. It is a waste to cool the food to a lower temperature than that to be found in the cold store, but it is extremely dangerous to leave any cooling to be done by the cold store.

The storage of frozen foods is, if anything, more critical as regards drying and flavour losses than is the actual freezing, principally because the food is in the cold store longer than it is in the freezer, but also because, unlike the freezer, the air in the cold store must be at the same temperature as the goods at all times. The slightest variation of the temperature of the store will mean that the foods warm up and cool down again, and each time this happens flavour and moisture will be lost.

Good cold storage practice demands a heavily insulated store with high grade doors and air locks so as to minimise heat flow through the envelope to the cooling coils, and thus reduce temperature fluctuation within the store. It also demands that all goods going into the store should be pre-cooled to store temperature, and great care taken to prevent warm air leaking in during removal of the goods.

As has already been stated, it is quite useless to spend time and money on producing a very high grade product if it is going to be spoilt during the last stages of distribution, and it is therefore essential that low temperature transport be provided to carry the fish from Port cold store to Inland wholesale cold store, and then again from the Inland store to the shop. Again, under no circumstances must the shopkeeper be allowed to thaw the fish out, as there is then obviously no check upon how long he keeps it before it is sold (probably with an indication that it is quick frozen and therefore of supposedly high quality). The shopkeeper must therefore have a low storage counter from which the fish is sold in the hard frozen condition to the housewife.

Besides the freezing of ordinary raw fish, there would seem to be very great opportunities for the development of quick-frozen cooked fish dishes. At the present time most housewives think only in terms of frying fish, not so much because they do not know that fish prepared in other ways is very good, but because they have neither the knowledge or the ingredients required to make the special sauces which alone make boiled or steamed fish really attractive. Thus the shortage of fat for frying does most definitely have an effect on the quantity of raw fish sold in the shops.

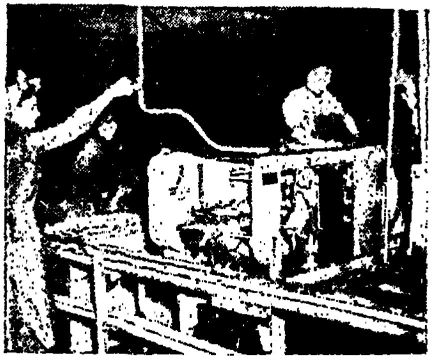
The possibility of establishing a really up-to-date kitchen under the supervision of a high-grade chef on the quay-side, where all kinds of fish dishes would be prepared and frozen, is most interesting. Not only can most attractive dishes be made from fresher fish, but there is also no doubt that certain types of fish could be used to make these high-grade products, which is not now what may be called an acceptable product to the housewife. For example, relatively unwanted fish such as Gurnet, could be made into a really good dish by a skilled chef, and thus material which is of low market value, could be turned into something with a relatively high market value.

In summary it may be said that the term "quick-frozen" must be thought of as covering a very much wider field than just rapid freezing, and does indeed represent a complete revolution in the whole basic principle of procuring and marketing fish.

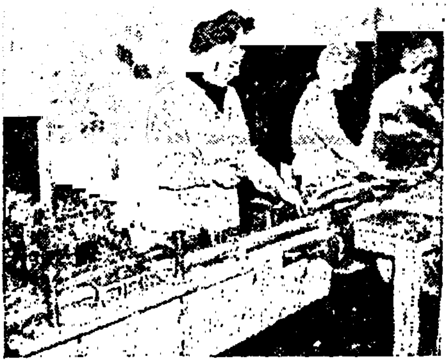
If this new process and marketing idea is properly developed, it may well mean a new era of prosperity for one of our oldest industries.

PROCESSING OF FISH

Preparation of Boneless Fillets



Cutting off heads, scaling, and gutting by machine



Securing the lids in a Canning Factory

Quick-Freezing : Placing tray of packed herring into the freezer

***Frozen Fish being packed into* cartons**

Illustrations by courtesy of the Ministry of Food in the U.K.

CANNING OF FISHERY PRODUCTS

By E. P. Sidaway

OF the various methods of preserving fishery products canning is perhaps the one offering most possibilities for future expansion. The markets for salted dried and heavily smoked fish have shown a steady decline during the past tweny-five years. Other types of food have replaced these products to a large extent in the diets of peoples who formerly consumed large quantities and there would appear to be little prospect of an increased demand for salted and dried fish. Frozen fish calls for special plant both for the actual freezing and the maintenance of the chain of low temperature storage from the point of freezing to the ultimate consumer. Moreover, fish smoked by modern methods also requires low temperature storage if it is to be maintained in an edible condition.

Canned fish although requiring special plant for its manufacture can be stored and shipped without special equipment and if adequately processed remains in good condition indefinitely.

The canning of fish has been brought to a high stage of perfection in a few countries of the world, notably in N. America, Japan, and in Norway. Many other countries have small canned fish industries, in most cases concerned with only one or two species. There are many other places where the waters team with fish suitable for canning but due to the lack of suitable markets the fishery remains relatively unexploited.

What then are the conditions required for the establishment of a fish canning industry? First there must be readily available raw materials of a suitable kind. It is desirable to have this supply available throughout the year, although under certain circumstances this is not essential. Secondly there must be a suitable site for the cannery with a supply of fresh water and fuel within easy reach. Thirdly there must be a supply of labour available either seasonal or throughout the year. Where fairly low cost labour is available and alternative employment possible canning operations could be confined to that season of the year when raw materials were most plentiful.

The machinery essential for fish canning consists of exhausting equipment, can seaming equipment, retorts, steam generating plant and motive power. Cans of course and boxes for shipping are also essential. The above equipment is manufactured in various countries throughout the world such as The Americas, Europe, Russia, Japan, S. Africa, India and Australia. The modern highly mechanised fish canneries of N. America employ

a large amount of auxiliary equipment such as fish cleaners, slimers, cutters and filiers, conveyers, can washers, labelling and packing machines, but these operations can be and are carried out successfully by hand where labour is to be obtained. It should be added that in addition to raw materials and actual equipment, engineers and technologists with previous experience of fish canning would also be necessary in setting up and operating a cannery.

The following is an outline of the operations involved in canning the various classes of fish.

General Procedure

Fish generally canned belong to either the pelagic or anadronous classes. Both these classes are usually taken by net or trap within a short distance from shore and the fish are therefore delivered to the cannery in fresh condition. Gluts occur often and in these events, the fish must be either salted or chilled in order to hold it until it can be canned. The herring-like fish are generally salted, while salmon may be iced. In California pilchards are held in large vats of chilled brine. Tuna which are brought from distant grounds are either frozen aboard the catching vessel or iced down.

The first operation is to clean the fish thoroughly, that is, remove the head, entrails, scales and wash away blood, slime and any other objectionable matter. Various machines are available for these operations, where the size of the fish is fairly uniform. Otherwise they are carried out by hand. The dressed and cleaned fish is then packed in the cans. Large fish are cut into can size pieces, small fish are packed whole. Fish such as herring that have been roused (dry salted) are packed immediately. If not previously roused they must be brined. After filling into the can sauce, brine, oil or dry salt may be added as required.

The next operation is exhausting. This is necessary in order to produce a vacuum in the can after sealing. Vacuum within the can is necessary for the following reasons:

(1) To keep the ends of the can collapsed under different conditions of temperature and altitude. Bulging ends are looked upon with suspicion.

(2) To minimise strains on the can seams during processing.

(3) To reduce chemical activity within the can during storage. Corrosion is accelerated in the presence of oxygen.

(4) To inhibit the growth of any surviving bacterial spores which require oxygen for growth.

There are three ways of obtaining a vacuum in the can. The method most generally used and the simplest is the heat exhaust.

The fish in the cans with the lids crimped loosely is passed slowly through a steam heated box or water bath during which the temperature of the contents rises to about 160-180 degrees F. Water vapour generated within the can at this temperature displaces air. The can is then immediately sealed. Alternatively the fish are passed through the exhaust box without covers and are tipped at the end to remove liquid collected or they may be passed through upside down on a wire mesh screen. The sealing must, however, be done while the can is still hot.

The second method is known as mechanical exhaust. By this method the filled can passes into a vacuum chamber and is sealed under vacuum. This method is widely used but has the disadvantage of requiring extra mechanical equipment. The hot exhaust, moreover has the advantage of removing some undesirable odours and flavours and this is especially true when the effluent is dumped before sealing. This effluent incidentally may be collected and any oil present recovered by settling.

The third method consists of blowing air out of the headspace in the can with a jet of steam at the moment of sealing. It is not generally applicable to fish canning.

After exhausting and sealing the cans usually receive a wash in hot water with or without soap to remove adhering debris. They are then ready for the retorting or processing. This is the really vital stage in the canning process.

Retorting has superseded entirely the old water bath method of cooking. The retorts are large cast iron vessels with sparge pipe connections for leading in steam and distributing it throughout the cans. The exterior is insulated with asbestos and the heavy door which can be swung out of the way has some form of tightening device so that it may be tightly closed with a gasket. Retorts may be either horizontal or vertical. Vertical retorts allow for better distribution of steam but have the disadvantage of requiring hoisting tackle and their capacity is limited. In Pacific American fish canneries long horizontal retorts are used. These are from 15 to 20 feet in length.

In the retort the cans are cooked under pressure, the pressure and hence the temperature varying with the type of product being canned. Fish containing bones are usually processed at 230°F. to 250° F. while some crustaceans and shellfish are processed at lower temperatures since they are easily discoloured and broken down by higher ones. During processing the bacteria present in the cans are destroyed. In some cases they may not be totally destroyed but are rendered dormant. Thus the fish may be kept indefinitely without spoilage taking place.

At the end of the processing period the cans are cooled rapidly and may or may not be washed again with a detergent. Rapid

cooling is necessary to arrest cooking which otherwise would continue and detract from the quality of the product. Many canners use pressure cooling devices whereby the cans are cooled in the retort by flooding it with cold water, maintaining the pressure meanwhile by the introduction of compressed air. Reducing the pressure within the retort too suddenly may result in distorted cans and strained seams. An increasing number of fish canners are introducing temperature recording and controlling devices on retorts and exhaust boxes.

When cooled and cleaned the cans are stored in a warehouse ready for labelling and shipping. Samples are withdrawn for incubation and examination to check the operation of the retorts. Some canners use the system of bulk incubation of all stock in a large heated room. Cans showing deformation are discarded.

An adjunct to many canneries though not part of the canning equipment proper is some form of smoking kiln. Sardines, kippers, kipper snacks are all smoked before canning. Other kinds of fish such as salmon, anchovies, shad and oysters also may be smoked before canning.

Different classes of fish require somewhat different methods of preparation in order to render them suitable for canning.

Herring and Herring-like Fish

Examples of this type are canned herring with or without sauce, pilchards or sardines, kippers, kipper snacks, smoked anchovies, etc.

Some form of preliminary dehydration of this type of fish is necessary. This may be accomplished by

(1) Rousing with salt.

(2) Precooking with steam either before or after packing in cans.

(3) Smoking or drying in warm moving air.

(4) Hot smoking or baking (temperature 140°F. - 180°F.).

(5) Frying in brine or oil.

With the exception of kippers and kipper snacks the fish are merely beheaded and gutted and placed in the cans whole. Kippers are split down the back and beheaded, while kipper snacks are smoked herring fillets. Tomato or mustard sauce, brine or oil are added to the can before closing. From this point processing follows the general procedure already outlined.

Salmon

Salmon are beheaded and gutted, cut into can size slices, the slices filled into the cans, a small amount of dry salt added and the can closed. Processing is then as already described.

Tuna

Tuna are received at the cannery either frozen or in ice. If frozen they must first be thawed. They are then gutted and washed, placed on wire screens fitting into trucks and run into steam boxes where they are steamed for hours, the time depending on the size of the fish. Bonito weighing 5-12 pounds are steam cooked at 216°F. for 2 - 2½ hours while blue fin weighing 60 - 200 lb. require from 5 - 9 hours at that temperature. After precooking they are cooled in air for 24 hours. This makes the meat firm for handling. The head, skin and bones are then removed, the dark meat is scraped away and the large pieces of white meat cut to can size and packed.

Processing then follows along general lines. Oil and salt are added to the fish before closing.

White Fish

White fish are canned in some countries. Since the flesh of white fish is low in fat and high in moisture it requires special treatment. Only very fresh fish is suitable for canning. The fish is first steamed for 10 to 20 minutes. It may be either steamed whole after which the flesh is flaked from the skin and bones or steamed in the form of fillets. The flaked fish is then packed tightly in cans with a small amount of salt.

Crustacea

Crustacea must have the shell removed before canning. The first operation therefore is boiling, and this is often done aboard the catching boat which delivers them to the cannery.

The meat is then removed from the shells, washed brined and pressed lightly to remove excess moisture. In order to prevent discoloration in the can the meat is dipped in a weak solution of some organic acid usually citric or acetic. The cans are lined with vegetable parchment to prevent blackening of the interior of the can and discoloration of the meat.

Shellfish

Clams, oysters and mussels must also be removed from the shell for canning. After washing with powerful sprays of water they are passed into steam chests through which they travel. This causes the shell to open and the exposed meat is either shaken or washed out. The meat is then washed carefully to remove sand and the stomachs are opened and washed. The black tips of the syphons are cut off. Clams may be canned either minced or whole, oysters and mussels are packed whole. The so-called nectar (the shell juice which spills out during shucking) is collected and used to fill up the cans. Excess nectar is often canned by itself as clam nectar. Oysters are also smoked and canned in oil.

In addition to the foregoing many other types of marine

products are canned but space will not permit their being dealt with here. Such products include fish pastes, fish roes, squid, cod livers, fish balls and chowders.

Processing times and temperatures recommended for the classes of fish dealt with in this article are shown in the accompanying table.

PROCESSING TIME AND TEMPERATURE FOR SOME COMMON CANNED FISHERY PRODUCTS

Product	*Type of can*	*Process Time minutes*	*Process Temp. Deg. F.*
Salmon	1 lb. flat or tall	90	240 to 245
	½ lb. flat	80	240 to 245
Sardine (pilchard) ...	1 lb. tall	75	240
	1 lb. oval	65	240
	½ lb. oval	50	240
Sardine (Small herring)	¼ lb. oil	45	240
Mackerel	1 lb. oval	75	240
Tuna	½ lb. flat	75	250
	¾ lb.	95	240
	4 lb.	230	240
White Fish (Flakes) ...	½ lb. flat	55	240
Herring	1 lb. oval	65	240
	½ lb. oval	50	240
Clams (Razor)	No. 1 picnic	45	220
Clams (Soft Shell) ...	No. 1 picnic	20	240
Oysters	½lb.	10	250
Crab	307 x 202½	70	228
	401 x 211	80	228
	307 x 408	80	228
Crab (King)	307 x 202½	90	220
	401 x 211	80	228
Shrimp	No. 1 picnic	10	250
Lobster	¼ lb. (300 x 108)	40	240
	½ lb. (207 x 200)	45	240
	1 lb. (404 x 206)	75	240

Taken from U.S. Dept. of Interior, Fish and Wildlife Service, Research Report No. 7.

BUCKLING

by C. R. Leiding

(*Managing Director*, Pommer & Thomsen Ltd.)

FROM time to time the accepted canons of preparing food for the table are upset by the arrival of a new method which purports to be better than the practices hitherto accepted and applied.

In the herring trade for many years past now the different categories into which herring landings could be classed for subsequent preparation into a meal were as follows:—

1. Fresh herrings, to be grilled or fried by the housewife.
2. Kippers.
3. Bloaters.
4. Processed or " marinated " herrings.

To these new varieties has now been added a very attractive and palatable new method of preparing herrings for the table, this product having been extensively marketed in recent months under the name of " BUCKLING." This new variation in the preparation of a favourite fish for the family table has been known, especially on the Continent, for quite a number of years. It is safe to say that the BUCKLING has held a similar position in the appreciation of the general public throughout such countries as Belgium, Holland, Germany, Poland, Czechoslovakia, etc., to that enjoyed in Great Britain by the kipper. Both the kipper and the BUCKLING are smoked, and it is this flavour which would seem to appeal to so many consumers.

The methods of preparing the two, however, are entirely different, and the manner in which the BUCKLING can be partaken of is more varied than the kipper. What actually is a BUCKLING? It would appear to be a derivation of a name which has been internationally noted in many terms applicable to herring curing. It is said that several hundred years ago the man who discovered the process of preserving herrings through the application of salt was a Dutchman by the name of William Beukel. On the Continent even to-day salt herrings in barrels are often referred to as " Pokel-Herrings," and the process adopted by this Dutchman undoubtedly is reflected in the British word " pickle "-cured-herrings, denoting the same preserving method. It would appear that the roots of the word " BUCK-

LING" are not very different from "pickling" and this assimilation would tend to explain the origin of the name.

What is the method of producing the BUCKLING and what are the advantages claimed by smoking herrings in this manner as compared with the orthodox way of producing kippers? In adjudicating this, the present day conditions of food supplies have to be taken into consideration, because such items as fuel (gas, electricity), cooking fat and any easy manner of preparing a meal have considerable bearing upon the introduction of a new article of food. The advantages claimed for the BUCKLING are:—

1. They are already cooked and therefore ready to eat without any further teatment; an easy meal. In point of fact, in all Continental countries, BUCKLING are eaten cold. As yet, only a certain section of the British public have taken to eating fish cold (except in hors d'oeuvres), but no doubt with increasing knowledge about the BUCKLING, this habit of readily eating them as they come out of the box will increase. Although they can be eaten cold, it does not follow that they have to be eaten in this manner. They can be heated in the same way as a bloater, either in the oven or under the grill. They must never be fried.

2. Since it is the essence of BUCKLING consumption to partake of them as they are, i.e., cold, they require no further fat for cooking (even when re-heated they require no extra fat), and this leads to what is perhaps one of their greatest assets, viz.:—

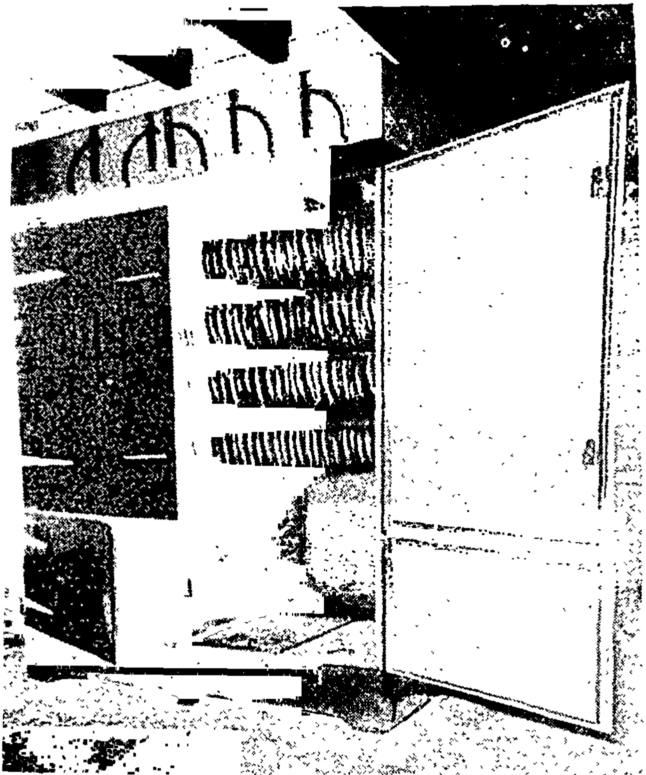
3. No smell! However much a kipper is enjoyed at any meal, there is always the offensiveness of the preparation which, whilst perhaps not offensive to the person about to eat a kipper, yet seems noxious to those who have gratuitously to endure the not always pleasant vapours eminating from the kipper pan.

4. The exceedingly appetising flavour of a BUCKLING. The combination of slow cooking herrings having at the same time smoke infused, is a process quite unknown to any other product, and this accounts for the fulsome flavour. What is the definition of "flavour"? Surely a mingled sensation of smell and taste, and in the BUCKLING production, to this distinctive flavour, the characteristic quality of a good herring is added.

These would be the points in favour of BUCKLING which, one should imagine, would be sufficiently attractive to make the BUCKLING a very acceptable addition to the known varieties of herrings prepared for the table.

With regard to the production of BUCKLING, there are several methods in use, from the very simplest small brick ovens to the very elaborate automatic kilns which are used on the Continent. The primary difference in production between a kipper

CURING OF BUCKLING



Open modern gas oven for the processing of buckling showing racks containing herrings ready to be cooked. Note removable plates at bottom.

Below :
Herrings hanging in racks drying prior to being processed in gas ovens.

and a BUCKLING is, of course, that a kipper is produced by cold smoke and the BUCKLING is produced by what one might term a "hot smoke" method. A kipper is split and gutted, a BUCKLING is a whole herring ungutted. Most of the brick ovens are now obsolete, the element of control in these old fashioned ovens being too uncertain. One of the latest factories for the production of BUCKLING is operating an automatic kiln, which consists of three identical compartments which are heated by seven external fire boxes. The trouble encountered with this method, however, was to keep the smoke absolutely hot. Without this, the desired effect could not be achieved. During the last two years, a new method of preparing BUCKLING has been evolved in gas heated kilns which are operating now at Great Yarmouth with great success, and for which a Patent application has been made during recent weeks.

This type of gas oven is manufactured from sheet metal and is approximately 15ft. 0in. high by 6ft. 0in. wide and 5ft. 6in. deep. The inside of this oven is fitted to hold twelve steel frames, and the oven is closed by two doors which are in two parts, the lower part of each section giving access to the firing and the plates. These ovens are placed over standard gas jets fitted into burners, each of which has 50 holes. These burners are fitted into the gas oven from each side and are controlled through several taps connected to a 2in. gas main. On top, over these gas burners, are fitted removable $\frac{1}{4}$in. plates with handles, and along the bottom of the oven are adjustable flaps to take in and let out air, all burnt air being drawn through an outlet duct into the main chimney which carries away any particles of burnt air, etc.

In the front of the doors are fitted special slides which can be opened or closed according to requirements in order to create a draught. On top of the gas oven is a false roof containing metal flaps, which are lever-controlled from the outside to regulate the heat inside the gas oven, as well as regulating the escape of steam which, during the cooking process, has to be let out to avoid the formation of condensation. These regulating flaps are opened or closed from the outside by arc shaped levers which hold these vanes in any position required through thumb screws. There are altogether, six such vanes fitted, three on each side. When they are all opened there is a considerable draught created, which goes through the chimney constructed of galvanised sheeting and angles constructed in six sections at the top surmounted by a cap. The manufacture of this chimney is governed by the position where the gas oven is erected and the height has to be controlled in relation to the draught required.

Prior to filling the gas oven, the fresh herrings, after having been washed and brined the requisite time, are hung on speats which are placed in metal frames. These frames, made exactly to fit the ovens, are then placed inside the oven, and the processing now begins. It has not yet been decided which is the

better way of producing BUCKLING, namely whether to apply a measure of smoke first and then do the cooking, or cook the herring first and infuse the smoke as a final measure just before they are ready to come out.

The method adopted at Great Yarmouth is to cook the herring first, for which process the plates above the gas burners are removed and thin trays are placed between the lowest rack of herrings and the gas fires to collect any oil and also to prevent any waste matter clogging up the gas burners. The heat in the oven is carefully watched through distant reading thermometers which are placed at the side of each oven. The cooking process now begins, and the time required for this entirely depends upon the size, quality and nature of the herrings. This is a matter which has to be judged entirely by experience. As soon as the herrings are cooked, which is done with the regulating vanes fairly wide open to let the steam escape, the vanes are then closed and the plates placed across the gas burners and on these plates which get hot very quickly, are placed the beechwood chips which are employed for smoking.

The heat is now turned down, but still kept at a sufficient level to set the oak chips smouldering, and with a very small opening at the top in order to create circulation, the oven is now filled with a thick volume of smoke, which produces the attractive golden colour in due course. The time taken for the entire process varies from 4 to $4\frac{1}{2}$ hours, of which the actual cooking takes about $2\frac{1}{2}$ hours and the finishing smoking approximately $1\frac{1}{2}$ hours.

When the fish are finished, the gas is turned off, the vanes are opened and thereafter the doors are opened and the fish taken out. It is most essential to prevent the beech chips from catching fire. They must only be brought to smouldering through indirect heat.

The BUCKLING are now ready and are still hot when taken out of the oven. They are then placed in special frames, where they are cooled down prior to being packed in boxes for despatch. Owing to the nature of the finished article, it is impossible to use large boxes. On the Continent, BUCKLING are mostly despatched in $2\frac{1}{2}$ kilos (approx. 5-lb.) boxes, and no bigger box than 7-lb. should ever be used.

As soon as the BUCKLING reach the market, they should be consumed immediately. They certainly keep for quite a while, but if so, they must be exposed to the air. The essence of the BUCKLING trade, however, is to partake of them always when they are fresh and all dealers would be advised to avoid having a large stock on hand. It is by regular and not too big supplies that this business can best be developed, and the initial response which has been accorded to this new line by the trade in general is sufficient encouragement to continue the production of BUCKLING.

STORAGE OF FISH

By C. L. CUTTING, B.Sc., Ph.D.

FISH is a highly perishable food, and under ordinary conditions deteriorates rapidly owing to bacteria and their products entering the flesh from the belly cavity and skin after death. Any treatment which retards or arrests this process will extend the period for which the fish remains palatable. The traditional methods of preserving fish rely on salting, drying and smoking or a combination of these. The growth of bacteria is inhibited by a high salt content or by lack of moisture, and in the case of smoking by the antiseptics deposited on the fish. The modern methods depend on reducing or preventing bacterial multiplication by lowering the temperature of the fish by means of ice or actual freezing; and in the case of canning, bacteria are completely destroyed by the heat treatment that is undergone. Dehydration is a modern method of drying which yields a product that avoids many of the disadvantages of the traditional dried products.

STOWAGE OF WHITE FISH IN ICE.

To deal first with white fish such as cod, haddock, plaice, etc., these are now normally gutted immediately after they are taken from the sea and packed in ice in the fish holds. Experiments by Torry Research Station of the Department of Scientific and Industrial Research in 1929 (see Food Investigation Special Report, No. 37, "The Handling of Stowage of White Fish at Sea") showed that by greater cleanliness and improved care in handling the trawler's fish, the period for which it could be maintained in really fresh condition could be extended from the usual six or seven days to a maximum of ten or twelve days. To effect this improvement, the precautions recommended were thorough washing of the fish combined with careful handling; special attention to cleanliness of decks, pounds, baskets and fish room, which should as far as possible be made of metal rather than wood which is difficult to keep clean; the intelligent use of ample ice; the avoidance of damage to the fish by bruising; the use of liberal shelving in the hold to break the weight, or better still, packing directly into boxes at sea. Insulating the fish room reduces the rate at which the ice melts and thus reduces the risk of some of the fish deteriorating by becoming uncovered towards the end of the trip. The provision of refrigeration plant to maintain the fish room at a temperature just above the melting point of ice (32° F.) reduces the melting of ice and in that way ensures the quality of the fish, although there seems no reason why it should produce results any better than those obtained by thorough icing alone. Melting ice, of course, cools fish in the first place much more rapidly than cold air alone at the same

temperature. The incorporation of certain antiseptics into the ice has been shown experimentally to have a minor effect of lengthening by a day or two the period during which fish retains its freshness, but usually entails various disadvantages, and such substances are not usually permitted by the Ministry of Health. Of course ice itself should be produced in such a way as to be as free from bacteria as possible, in order not to contaminate the fish unnecessarily. Experiments have been made on the effect on the storage life of fish of excluding air and substituting an atmosphere of some other gas. Carbon dioxide has been found to exert a far greater preservative effect than nitrogen. Atmospheres containing various percentages of carbon dioxide have been tried experimentally. 60 per cent. delayed the growth of bacteria and the onset of the signs of bacterial decomposition, but produced effects such as bleaching of the skin, dullness of the eye and opacity of the flesh. With 30 per cent. carbon dioxide, no advantage was gained until twelve to seventeen days storage in ice, but the fish still remained quite edible up to twenty days although the flesh became rather soft.

Care to observe cleanliness, keep the fish chilled and handle them expeditiously should, of course, be exercised not only on the fishing vessel but also during subsequent marketing and distribution. The ideal would be to pass on, whenever possible, fish boxed on the fishing vessel without opening except perhaps to replenish with ice.

FREEZING OF WHITE FISH.

Between the two Wars, overfishing of the near fishing grounds led to larger vessels being built to fish the lucrative distant grounds near Iceland, Bear Island, the White Sea and Greenland. The length of the journey back to port made it inevitable that a fair proportion of the fish was often more than 12 days caught, and therefore, even with the best possible handling, stale by the the time it reached the consumer. By freezing hard, and with storage at a sufficiently cold temperature (15°F.) the bacterial decomposition of fish can be arrested. Nevertheless, even at this temperature, certain other slow physical and chemical changes continue to cause deterioration, at a rate which is however reduced by further lowering the temperature. At temperatures of —5° to —20°F. white fish remain in a condition as good as fresh for four to eight months respectively, and can still be acceptably eaten after one to four years, provided certain other requirements are also satisfied. These are that the fish must be very fresh (for example, still in *rigor mortis*); rapidly frozen by almost any of a variety of methods now available, such as immersion in brine, exposure to a cold air blast or freezing between cold plates, so that the temperature in its thickest part is reduced from 32° to 23°F. in less than two hours (corresponding to an overall freezing time of about 3 hours); and ".glazed," i.e., sprayed or

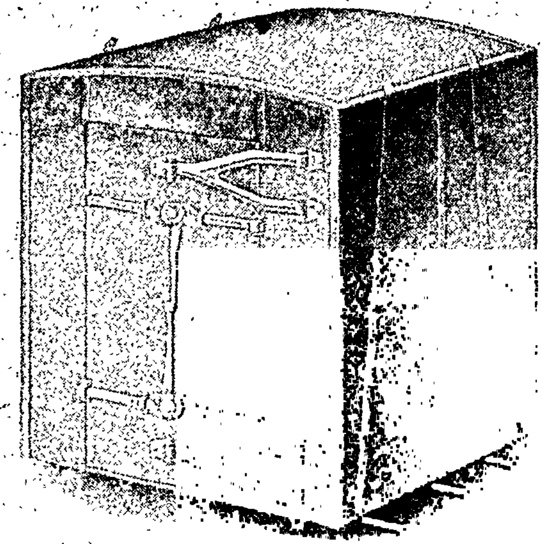
dipped in water so that a coating of ice is deposited on the surface of the fish prior to cold storage to prevent drying.

For freezing to be a solution of the problem of improving the indifferent quality of much of the fish landed in Britain from distant waters it is clear that it must be applied on or close to the fishing grounds. Although freezing fish at the port after, say, ten to twelve days in ice may be an advantage in inhibiting the rapid deterioration that occurs at the onset of staleness, the commodity produced, clearly will not compete in quality with fish properly frozen on land near to fishing grounds, as in Iceland, Norway, Canada and Newfoundland, or on board trawlers or factory ships, both of which alternatives have already been proved technically possible.

On some pre-war French freezing trawlers, fish were not gutted before freezing, nor were they "glazed" after freezing; which might not matter for, say, a six weeks' absence from port, provided the storage temperature is low enough to prevent undue dessication, although in the case of brine freezing thorough washing to remove salt is important. Freezing only a proportion, say the first third of the catch, the remainder being brought home in ice in the normal way, would lead to a considerable improvement in average quality and also presumably an increase in the average price fetched under conditions of a free market. The freezing of fillets as carried out by a German vessel during the war (as described in British Intelligence Objectives Sub-Committee Final Report No. 493 "Certain Aspects of the German Fishing Industry") has the advantage that only edible material is frozen and that the blocks of fillets can be packed compactly, while such a project requires a white fish-filleting machine and an offal plant in operation aboard the fishing vessel.

Cold stores generally should probably be cooled by grids of pipes in preference to air circulation, which appears normally to increase drying during storage, leading to "freezer burn." Drying can be further reduced by wrapping in waxed paper, preferably backed by aluminium foil, although evaporation is in any case of minor consequence at storage temperatures as low as —20°F. When fish frozen while fresh are thawed, they can be handled and stored for a further period in ice without decomposition occurring much more quickly than is the case with unfrozen fish.

By the planned utilisation of proper freezing and cold storage it would be technically possible to convert fish into a relatively imperishable commodity, the distribution of which could be more or less evenly regulated, so that any species could be obtained at any time of the year of a uniformly high quality, as fresh as when it left the sea.



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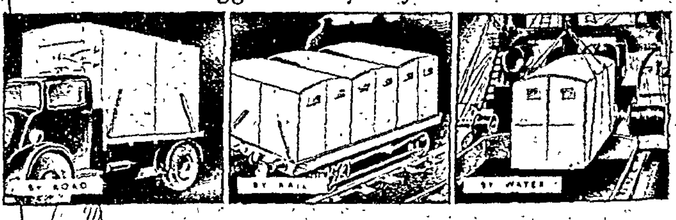

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STOWAGE OF HERRINGS.

The problems associated with the storage of herrings are different in a number of aspects. They are mostly caught close to our coasts overnight and landed ungutted early next morning. The catch is irregular and fishing at full capacity would result in frequent gluts. There is a tendency on the part of fishermen to restrict their activities by limiting the number of vessels engaged and the number of nets shot per vessel so that the catch landed should not exceed handling and utilisation capacity. When the nets are hauled in, the fish are heaped up in the hold on shelves perhaps two or three feet apart frequently to the detriment of those at the bottom. With "feedy" fish on warm summer nights, the belly walls are often partially digested by the time they reach the kipperer, and rarely, if ever, does the inland consumer obtain anything approaching really fresh herrings. Work at Torry Research Station just before the War shows that in order to improve the quality of herrings reaching the consumer, without resorting to freezing and cold storage, normal present practice must be improved upon in two main directions, viz.—the efficient chilling of the fish with ice and the reduction of pressure and of handling by stowage of the fish in boxes throughout the complete chain of transport from net to consumer.

Ideally, herring, like white fish, should be iced and preferably boxed at sea immediately they are brought over the side of the ship. One part of ice by weight to three of fish is sufficient to cool the fish to 32° to 36° F. The boxes could then be hauled ashore with the minimum of damage to the fish, but it would probably then be advantageous to transfer fish that are to be sent away in the fresh condition to a lighter non-returnable box with sufficient ice to keep the fish thoroughly chilled throughout the journey and up to the point of sale. Reasonable cleanliness, e.g., washing and scrubbing of boxes, decks and pounds should be regarded as essential. The preliminary experiments suggested that eviscerating and splitting herrings at the port prior to despatch produced little improvement in the quality and palatability, but such a practice might nevertheless well be extended, on the analogy with the growing popularity of white fish fillets, since it yields a clean, ready to cook, commodity. Only eviscerating at sea, impracticable on a small boat, removes digestive fluids before they have time to attack the fish and results in improved condition of the belly walls which is an important consideration for producers of kippers. At the best, herrings keep in really first class condition for only about half a day at 60° F. and two or three days at 32° F. though they remain edible for two or three times as long. This rapid rate of deterioration of herring can be controlled and the problem of evening out a very seasonal supply solved by proper refrigeration.

FREEZING OF HERRINGS.

Successful freezing of herring requires the same precautions as already mentioned for white fish, except that good quality herrings differ in containing a high proportion of fat, which tends to develop unpleasant rancid flavours unless the fish are thoroughly "glazed" and stored at a very low temperature. A temperature of —20° F. is necessary for a storage life in really first class condition of about six months which is sufficient to provide fresh herrings all the year round. Large scale trials carried out in the past few years by the Ministry of Food and Herring Industry Board have demonstrated to the satisfaction of retailers, kipperers and canners the success of proper freezing and cold storage as a method of preservation. Furthermore, the distribution of herrings in the frozen condition resulted in the delivery all over Britain often for the first time of herrings possessing a flavour as delicate as when newly landed.

SMOKED FISH.

Smoked fish constitutes an impressive proportion of the home consumption. Depending on the amount of curing undergone, the boxed product remains good for up to a week at 60° F. and for two or three weeks at 32° F. Freezing extends the storage life to a month or two at 15° F., several months at —5° F. and up to a year at —20° F. But a better product is always obtained by freshly smoking cold stored fish rather than cold storing smoked fish.

Further information on matters connected with the storage of fish can be obtained from the Superintendent of the Torry Research Station, Aberdeen, of the Food Investigation Organisation of the Department of Scientific and Industrial Research.

BACTERIA AND THE FISH SHOP

By E. P. Shepherd.

THE action of micro-organisms (moulds and bacteria) on fish plays an important part in producing many of the problems that arise in its distribution. Firstly, most forms of putrefaction are the result of bacterial action, and therefore the prevention of waste, requires that close attention must be given to the elimination or control of such action. Secondly, fish and other foods may act as carriers of dangerous germs and thus cause disease. Alternatively, germs may grow on the food, and by producing poisonous substances, called toxins, may give rise to various forms of food poisoning. Thirdly, bacterial growth may not be sufficient to make the food unfit for human consumption, but by producing changes in the normal character of the product, in relation to appearance, odour and taste, may affect its market value.

Some knowledge of the circumstances under which micro-organisms appear, grow and reproduce, seems necessary, if a food distributor is to control the effects outlined above. The responsible organisms may be broadly classified in two groups, Moulds and Bacteria. The former normally grow under circumstances unfavourable to the propagation of the latter, require under normal storage conditions a longer time than the latter to produce their effects, and since Mould is a superficial growth, it can usually be removed without affecting the remainder of the food. It should be noted that there are thousands of types of mould and that the air is charged with microscopic mould spores, which, acting in a similar manner to the seeds of ordinary plants, come to rest where there is a necessary food supply and subsequently germinate, grow, and reproduce.

Bacteria, however, constitute the greatest menace in food handling problems. These tiny forms of plant life, which can only be seen with a most powerful microscope, play a very important part in the economy of nature. As a result of their activities, dead tissue is broken down and simplified, so that it becomes available to provide food for the higher plants and these subsequently become the food for animals. Thus, without bacteria, life as we understand it on this planet, would be impossible. Therefore the putrefaction and decay of food by bacteria, may be considered a perfectly normal process, and man's attempts to preserve food are really a race against nature. There are probably tens of thousands of types of bacteria, and a small proportion of these are also capable of producing disease in plants and animals. Most of these latter organisms can also exist or grow on dead tissue, so that disease producing organisms can be transferred through the medium of our food supplies.

The protection of food from attacks by bacteria, requires two distinct approaches. The first of these, concerns the prevention of the bacterial infection of food. In this connection, it is an important fact, that for all practical purposes, organisms have no power of individual mobility, and thus there must be vehicles to bring about their transference. Almost anything which comes into contact with the food, may be considered a potential carrier of organisms, unless precautions are taken to remove the organisms before contact.

Many organisms are transferred through the air by the medium of dust or droplets of water and appropriate cleaning methods and protective shop fittings can minimise these effects. When fish are taken from the sea, they are sterile on the surface, since sea water exercises an antiseptic effect. The intestines of fish, however, contain billions of organisms and as a consequence of inefficient evisceration, many of the intestinal organisms may be distributed over the fish generally. Personal hygiene of the highest order, is essential on the part of everyone handling fish, since skin, hair, and clothing can provide large numbers of organisms. Equipment of every description must be kept clean and free from organisms, and improvements in design and materials have made and can make an important contribution to this end. Chemical antiseptics, such as hypochlorites, can also assist in this direction, but an antiseptic is no substitute for conventional cleaning methods, which must always precede any treatment of the equipment with antiseptic solutions. Finally, the transference of organisms by vermin of every description should receive attention of the highest priority. The house fly, for example, not only deposits putrefying organisms on fish, but since in thrives, in a filthy environment, it often transfers dangerous disease producing organisms. Although the complete elimination of the fly from the shop may be impossible, a great reduction in fly population can be achieved, by removing any accumulations of putrefying material which automatically becomes the potential breeding ground for flies.

Having reduced the numbers of organisms on the food by the methods outlined above, the second and complementary approach to the problem consists in either preventing the growth and reproduction of such organisms or their complete destruction. Methods of food preservation, such as salting, smoking dehydration, refrigeration and heat sterilisation, have one of these objectives in view. As far as the fish retailer is concerned, the control of temperature in relation to the growth of organisms is of great importance and will be briefly considered.

Bacteria reproduce by division and since under ideal circumstances they are capable of reproducing themselves once every twenty minutes, it is obvious that in a few hours, the progeny of a single organism will amount to millions. Organisms are, however,

very sensitive to the temperature of their environment, and most putrefactive organisms grow best at summer temperatures of about 70°F., and disease producing organisms at blood temperature or about 98°F. Decreases or increases from these temperatures brings about a reduction in the activity of these organisms, so that within the region of 40°F., reproduction has either ceased or is very greatly retarded, and when ice is in the product, all organisms cease reproducing. The latter phenomenon is probably not due to the temperature, but to the fact that the product is dehydrated when completely frozen. It should be noted, however, that although freezing will prevent putrefaction, organisms may still be alive after some months of freezing, and if these happen to be disease producing organisms, they may still cause trouble.

Similarly a rise in temperature to about 115°F. results in the cessation in the growth of most organisms and a temperature of 135°F. maintained for a considerable time, would destroy most organisms. There is, however, considerable variation in the resistance of organisms to the effects of heat and in the canning industry, where it is necessary that there should be complete destruction of the organisms in the container, it is normal practice to process at a temperature well above the boiling point of water for about half an hour. Thus by the manipulation of heat effects, the growth of organisms may be inhibited or the organisms may be destroyed.

It has not been found possible within the limits of a short article to consider many of the implications of the facts stated above, but sufficient has been stated to demonstrate that the fishmonger can exercise a considerable control over the general quality of his commodity, by a combination of hygienic handling and efficient storage methods. At all stages of food distribution, the lessons of bacteriology can be applied and a deeper understanding of this subject by those concerned, will result in benefits both to the fish industry and the public.

THE UTILISATION OF FISH WASTE

A SURVEY has been carried out by the Pacific Coast Station of the Fisheries Research Board to ascertain whether everything possible and practical is being done to make full use of fish waste. A report on these investigations drawn up by Norman E. Cooke and Neal M. Carter was published by the Board in their "Progress Reports." In view of its importance we are publishing below extracts from this report.

Recently there has been a great deal of interest shown in the field of fisheries by-products. This interest has come not only from fishing companies seeking to utilize the fish as profitably as possible, but also from various pharmaceutical and manufacturing firms interested both in developing new products and in finding cheaper or better sources of raw materials for products already established.

Investigations by this Station and other similar organizations have from time to time in the past drawn attention to materials derivable from fish and other marine products. At the present time further investigations are taking place both here and elsewhere and in many cases the full scope of the possibilities is not yet known.

This article reviews some of those products developed in the past which are being, or possibly could be, utilized commercially today. To a lesser extent it also reviews a few present and projected lines of research which may prove profitable to the industry.

BY-PRODUCTS FROM PROTEIN MATERIAL

In the filleting of many fishes the proportion of waste is very high, as much as 80% from some flatfish. This waste may easily be separated into various fractions of more or less value. One major constituent of this waste is flesh which adheres to the head bones and fins. While it is difficult to utilize this flesh as food it still is nevertheless first-class protein. At the present time, in British Columbia most of this material is converted into fish meal. There are, however, several other possibilities which might prove more profitable:

Protein Hydrolysates—One likely line of exploitation is that of protein hydrolysates sometimes used for nutrition in cases of impaired digestion. Last year this Station was approached concerning supplies of raw material by a large Canadian pharmaceutical house which was interested in using fish flesh for this purpose. A recent trip by one of the authors to California

included a visit to a fishing company which was producing hydrolysates in large quantities. Another use for these hydrolysates is in making digests for bacteriological media. With the discovery of penicillin and its production on a commercial scale the demand for similar media has increased enormously. The Japanese have been using a fish hydrolysate for some time in the manufacture of penicillin.

Amino Acids—Along similar lines is the production of purified amino acids from fish proteins. Some of them are essential for proper nutrition. Fish protein, like that of other animals, contains most of these essential amino acids, but vegetable protein is often lacking in one or more of them. The foregoing fact accounts for the widespread use of fish meal as chick feed.

Issue No. 69 (p. 66) of these Reports refers to work at this Station in amino acids of British Columbia fish flesh and further details are reported in full in the Board's Scientific Journal. More work is in progress.

Glue—Although fish glue is manufactured on the Canadian Atlantic coast, the British Columbia fish industry has not shown any definite interest in fish glue production in spite of the fact that both fish glue as well as raw materials for making other types of glue are frequently imported to meet Canadian requirements.

Fish glue can be produced either from the whole heads, skin from filleting waste, or from the stick-water of reduction plants making fish meal and oil. It was demonstrated 15 years ago at this Station that halibut heads can yield an excellent glue. Equipment for its production on a large scale was designed, and described in the Board's Scientific Journal.

Plastics of Fish Protein—At the Halifax Experimental Station investigations were conducted for some time on the producing of plastics from fish flesh scrap (Atlantic Progress Reports No. 7 and No. 9). This work has recently been resumed.

Synthetic Egg White—Synthetic egg white, prepared from fish protein, has been commercially available and used for a number of years in Germany.

BY-PRODUCTS FROM INTERNAL ORGANS OF FISH

Bile Acids—In response to many inquiries about sources of fish bile, this Station undertook to ascertain something of the availability of cost of collecting bile from the gall bladder of some British Columbia fish. Some results were also obtained from halibut bile. It was estimated that the yield would be between 3 and 4 pounds per day per boat.

In the commercial collection of fish livers, the gall bladder, if present and evident, is often carefully removed and thrown away. There is a demand and a market for the bile from these bladders; if they are not considered worth the trouble of saving at present,

possibly encouragement may arise from expected developments in the utilization of other parts of the viscera as suggested under following headings.

Enzymes—Fish as well as all other animals have in their digestive tract certain enzymes which digest their food. These enzymes are important industrially in several ways because when isolated they can be used to digest or otherwise modify certain material. In the leather industry proteolytic enzymes from the pancreas of cattle and swine have been used for a good number of years as "bates." The enzymes from some kinds of Atlantic fish equal or even excel the enzymes from mammalian sources in their suitability as leather bates. More recently another use for these enzymes, that of making protein hydrolysates such as mentioned above, has presented itself.

Last summer this Station was approached regarding a commercial pharmaceutical supply of these enzymes. Some estimates made at that time indicated that the pyloric caeca, the organs in which the enzymes occur, could be collected, preserved and shipped at a cost considerably lower than that of beef pancreas. Local leather tanneries probably could also consume some of this material.

Insulin—Shortly after the discovery of insulin experiments at the Halifax Experimental Station showed that a very pure insulin could be produced from fish and some was manufactured commercially on the Canadian coast for a while. Samples of insulin were also prepared from Pacific coast halibut. As time progressed it was found that insulin could be made more cheaply from ox pancreas and the manufacture from fish ceased.

At the present time the demand for insulin is greater than the supply and it would seem that is might again be manufactured from fish. It is also reported that certain diabetics who must take insulin react unfavourably to some preparations of the material from mammalian sources. In some fish the tissue in which the insulin occurs is a distinct organ; therefore it is possible to obtain a specific product and it would seem plausible to suggest that such insulin might have, at least in the cases just mentioned, properties that might make it a valuable alternative to the insulin prepared from mammals.

Protamine—Protamine, a particular kind of protein obtained from the milt of some fish, was found a number of years ago to be beneficial in insulin preparations for the treatment of diabetes. The principal source of supply to meet Canadian requirements has been from British Columbia salmon milt, and the quantity needed has not been great. Recently, however, it has been claimed that the effect of protamine on the action of insulin can be similarly applied in the administration of penicillin. Increasing interest on the part of both Canadian and American pharmaceutical firms may cause a further demand for fish milts.

Arginine—It has been shown that when chicks are fed a diet devoid of arginine and glycine, they develop a peculiar type of paralysis; furthermore they must have ample supplies of arginine for the proper growth of feathers. If salmine, the protamine from salmon milt, is hydrolyzed it is found that the resulting mixture contains about 85% arginine and it is relatively easy to separate this material from the mixture. A market for arginine in the poultry feeding industry is conceivable, and if it arises the logical sources of large amounts of the substance would be fish milt.

Sex Hormones—The sex hormones which are becoming increasingly important in clinical medicine are at the present time commercially produced from mammalian sources. Some of them have been demonstrated to be present in the gonads from fish, a source that is readily available should a greater demand arise.

PRODUCTS FROM THE SCALES OF FISH

Pearl Essence—Pearl essence is prepared from the chemical substance guanine which occurs in shiny lustrous plates on the scales of many fish. This compound when suspended in suitable media is used for imparting a pearly lustre to a variety of articles, including costume jewelry such as imitation pearls. Canadian firms import this essence from United States and Europe while large quantities of the raw material, fish scales, go to waste particularly on our Pacific coast. Work at this Station showed that pearl essence of suitable quality can be made from British Columbia herring scales and recently several new requests concerning this material have been received, including a renewed interest in British Columbia sources.

Guanine and Caffeine—As was mentioned above, crystals of guanine can be separated from fish scales. Guanine is one member of a very large group of compounds known as purine derivatives. Another of the group is caffeine which occurs in both tea and coffee. Guanine can be converted into caffeine by way of another compound known as xanthine. During the war considerable quantities of caffeine were made this way.

Cystine—Fish scales, like hair, are composed largely of the amino acid cystine. This compound is another of the amino acids required for nutrition and very likely in time a large market will develop for it. Indeed even now at least one large fishing company is using fish scales for the commercial production of cystine.

Other Uses of Fish Scales—It has recently been found that fish scales when carbonized make excellent animal charcoal for use as an adsorption agent in clarifying, decolorizing and otherwise purifying liquids and solutions. Scales have also been used for some years in the manufacture of the foaming type of fire extinguisher.

LEATHER FROM MARINE SOURCES

As mentioned before, fish skins are a source of glue; but some skins which are merely a waste product of the filleting operations on this coast can be converted into a high grade attractive leather for novelty articles and other uses. It is odd that articles made from snake leather are commonly on the market while fish leather is comparatively rare. Examples of imported fish and snake skin leathers are commercially available in Vancouver. The process of tanning fish skins is very similar to that of tanning hides and is reported in several places in the literature.

Another source of leather is the hides of hair seals and some other sea mammals. The possible exploitation of these animals is also mentioned below.

BY-PRODUCTS FROM OTHER MARINE SOURCES

Glucosamine can be obtained from chitin and is a type of sugar derivative not commonly found elsewhere in nature. It could conceivably be a starting material for manufacture of a variety of otherwise difficultly-accessible chemical or pharmaceutical products.

BY-PRODUCTS RELATED TO FISH OILS

Oil is a major by-product of the fishing industry and in recent years the demand has greatly increased. The production and technology of marine animal oils has been treated extensively in this Board's Bulletin No. 59 and no attempt is made here to summarize the information therein.

A few points of interest, however, should be mentioned. The chief one is that at the present time Canada and many other countries are short of fats and every effort should be made to increase the output as much as possible.

Products from the Unsaponifiable Part of the Oil—These products have also been reviewed in Bulletin 59, but a few remarks concerning some recent applications seem to be in order.

Cholesterol, which makes up the bulk of the unsaponifiable material of many oils is the starting point for manufacture of 7-dehydro cholesterol which by ultravoilet irradiation is converted to vitamin D. Some fish meals from this coast have been recently analyzed at this Station and shown to contain about 3½ lb. of cholesterol per ton. Oil from the same meal contain as high as 25 lb. per ton. There are numerous solvent extraction processes which are capable of extracting this cholesterol from the meal and the oil at a low cost. At the present time cholesterol sells for $6.00 to $12.00 per pound.

Other sterols related to cholesterol are found throughout the animal kingdom. Some of these occur as 7-dehydro sterols, some of which, as noted before, can be converted to vitamin D. Marine

invertebrates such as mussels, scallops and the like have been found to be good sources of these compounds and at the present time vitamin D is being made elsewhere from them. Since British Columbia has extensive beds of mussels this raw material might be used here.

Squalene, another constituent of the unsaponifiable part of the oil, particularly shark liver oils, has recently been reported to be a good mordant for certain synthetic fibres, and an attractive price has been offered for supplies desired for the "finishing" of certain textile fabrics.

Lecithin, which occurs in salmon egg oil in amounts up to 18%, has applications as a wetting agent and also finds uses in the candy industry where it prevents "bloom" on chocolates.

Salmon egg oil itself, together with ratfish liver oil, has properties that warrant its further investigation as a lubricant for special types of instruments or for precision machinery.

CONCLUSION

The above summary has been prepared with the intention of presenting a variety of uses for waste products resulting from the processing of fish as a food. No attempt has been made to canvas all the possibilities. To indicate that this Board's technological Stations have been giving attention to some of these possibilities for a number of years past, reference has been made to Board publications only.

Other countries have developed many ideas for utilization of fish wastes, some of which have proved practical and profitable, others of which have not. In some cases labour cost is the deciding factor. In the course of a recent survey of fisheries technological processes used in Japan, one of the authors of this article found many products being made that would have little appeal to Western tastes; but other processes seen showed the ability to utilize many parts of fish entirely neglected on this coast. Examples were the recovery of the high content of vitamin B_1 and B_2 from the eyes of codfishes; manufacture of taurine from the waste liquors resulting from the canning of squid; and the production of a very delectable condiment sauce from hydrolysis of scrap flesh.

We make from the proteins of milk a nutritious and much-appreciated solid food called cheese, and even add certain moulds to develop peculiar flavours appreciated by epicures. Is it too fantastic to suppose that the proteins of fish scrap, at present made into products such as fish meal, glue and other materials not suitable for human food, could be converted into an entirely new type of food, perhaps analogous to cheese?

MODERN METHODS OF OBTAINING OIL AND MEAL FROM FISH

THERE are still a few people who only know that fish usually follows the soup, while thousands more associate fish with chips and know at least that it is a good food. It is too true, however, that when fish (especially herring) is too plentiful, it is often wasted or even thrown back into the sea. Living as we are today, in a world short of food, short of oil and short of fats, it is surely not the time to discard the herring, which is so valuable and rich in oil. When the markets for home supplies and export have been satisfied, further profit can be obtained by processing any supplies left over.

OIL FROM FISH AND FISH OFFAL.

Valuable oils may be obtained from various types of fish. In some cases such as herring, pilchards and sardines, a high oil content is contained in the flesh; in fish like cod, halibut, shark, etc., it is contained in the livers, and in certain types of whales in the head. Various methods are used to obtain the oil from these sources. Herring yields a first class edible oil which has been found suitable for margarine manufacture, it also goes to the making of soap, and lower grades are used for leather dressing and mechanical purposes. Where the oil is contained in the flesh a process consisting of four basic operations has been patented, consisting of cooking, pressing, screening and then separating for clarifying. Where the oil is contained only in the livers, jacketed cookers with provision for live steam injections, to break the cells are used and the resultant oil is then clarified and refined. Where more than a certain percentage of oil remains in the resultant meal or foots, this has to be removed by solvent extraction. Talking particularly about herring, the material is first cooked and whilst hot is passed through a special patented press, of the reduced worm type, the juice, called "liquor" when applied to herring pressing is later strained to remove solids and the oil is then separated from the stick water by special separators.

That is the 'bare bones' of the process of extracting oil from herring, etc., and talking of bones, they either stick in the throat or get thrown away, as waste, but not in a modern fish meal and oil factory. Here is the machinery and plant necessary to convert every scrap of waste or offal into a marketable product. Pressing the fish to extract the oil has been mentioned and it

may occur to the enquiring mind that there is some pulp left. There is. The trade name for this, is "press cake" which remains in a damp condition and when dried and ground makes a cattle feeding meal.

FISH MEAL.

This is the name given to the product of the surplus or waste from edible fish and if manufactured properly makes a cattle and poultry food of high value. A cycle of five main operations complete the process, which is totally enclosed and creates no nuisance or smell.

1. *Hacking*, to break up large bones and tear up large fish;
2. *Sterilising*, by indirect steam;
3. *Drying*, by indirect steam, hot air, mechanical disturbance;
4. *Exhausting steam and vapour;* and
5. *Grinding*, to make a fine meal.

MODERN FISH MEAL AND OIL PLANT.

Having outlined the cycle of operations and described the various processes for both oil and meal production, a general description of machinery and plant installed in a modern fish meal and oil factory follows.

It is a long way from the early methods of producing fish meal with odourous vapours polluting the atmosphere for miles around. The modern odour-free, hygienic fish processing factory owes something to the introduction of a *totally enclosed* continuous type plant in Germany during the early 1920's. These have since been developed and improved under the registered trade mark "Farramatic" to supply a world wide demand. A factory installing the latest "Farramatic" plant is regarded essentially as a food factory with all the aspects of cleanliness associated with the manufacture of food stuffs.

Inside the plant itself, the complete cycle of operations are totally enclosed and no obnoxious vapours or gases permitted to escape to free air.

The secret of producing fish meal of the best marketable quality is in the method of quickly separating and removing the steam and vapour from the raw material. Fish contains about 75% moisture. That moisture is removed by cooking and drying. The "Farramatic" machine has been so designed, that when carrying out these processes, the steam and vapours are quickly removed and passed into a de-odourising plant.

DEVELOPMENT OF OIL PRESSING PLANT.

A further progressive step has resulted in the perfecting of the press, which is the key machine in the processing plant for the extraction of herring oil. The "Farramatic" herring oil and meal plant, consists of (1) a pre-cooker, (2) patent press, (3) oil separating apparatus, (4) drying cylinders and (5) de-odourising unit. The oil in the herring and similar fish is for the most part contained in the tough cell tissues, which require softening by the application of steam, prepatory to pressing. This operation takes place in the pre-cooker, a steam jacketed apparatus, fitted internally with a tubular shaft, to which are attached arms and blades set at an angle to form both a stirring device and conveyor, for working the material from the inlet to the outlet. Steam is introduced into the pre-cooker, controlled by suitable valves. Time for cooking varies according to the quality and condition of the raw material. The product leaves the cooker in a mushy condition, ready for further treatment through the press.

The press is a self contained unit with a solid tapered worm shaft, revolving inside a cage. The worm is adjustable and can be eased off or more pressure applied as may be found necessary for the extraction of the maximum amount of liquor, which escapes through the cage and collects in a box from whence it flows through a pipe to a strainer. The strained liquor then passes through settling tanks and is eventually delivered to a separator, where the oil is separated from the liquor.

After extracting the liquor the "press cake" which contains about 50% moisture is passed through the drying plant. This consists of a series of steam jacketted cylinders, where the moisture content is reduced to a minimum, leaving an edible meal which is taken to a grinding plant for finishing and filling into sacks.

DEVELOPMENT OF WHITE FISH MEAL PLANT.

The processing of white fish differs substantially from that of herring and similar oily fish. To achieve satisfactory results it is essential that the basic operations are carried out at the correct temperatures. Too high a temperature would impair the products, the critical limits being so fine that any apparatus for this purpose should be designed to allow adequate control.

The latest "Farramatic" Fish Meal Plant comprises a hacking machine, steriliser, drying cylinder, grinding plant and de-odourising unit, the process being totally enclosed and continuous from the entry of the raw material to the discharge of the dried product.

The raw material is shredded by passing through the hacking machine, to ensure efficient treatment in the steriliser and

drying plant. The steriliser is a steam jacketed vessel for preserving the nutritious values of the material by cooking and destroying harmful bacteria during this operation. From the steriliser, the material passes through a series of steam jacketted drying cylinders. Inside the steriliser and drying cylinders, are revolving steam heated, tubular shafts. Each shaft is fitted with stirring gear, designed continually to work the material forward. The number of drying cylinders employed, depend upon the capacity of the plant. The material emerges from the final cylinder, dried and in the form of meal, which after grinding is put into sacks, ready for use. The steams and vapours arising during this process, escape through ample openings provided for the purpose in the cylinders, and are quickly drawn away by a powerful fan, through piping, to the de-odourising plant, where all gases of an objectionable nature are arrested and destroyed. These plants are thus rendered odourless and sanitary and can be sited in any convenient area without raising objection or causing a nuisance.

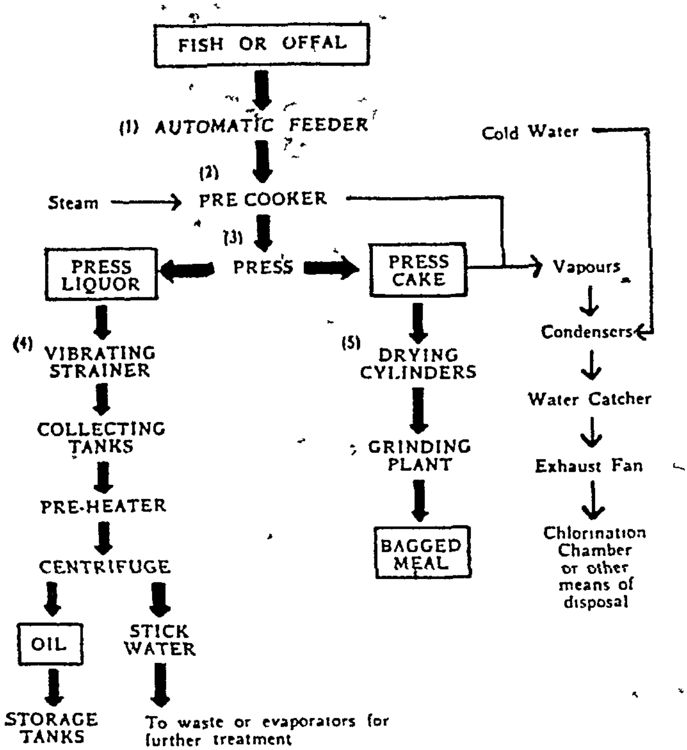
DUAL PURPOSE PLANTS.

A modern plant installed in a factory in Great Britain combines the two types of plants, already described, the white fish meal plant being complete, while the herring pressing plant delivers the press cake into the cylinders of the white fish plant, thus saving the extra nest of drying cylinders, usually supplied with an oil pressing unit and making it a dual purpose plant.

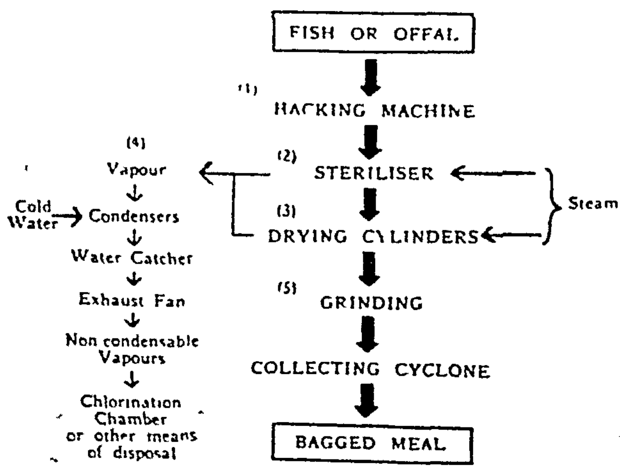
A few points to look for in modern fish meal and oil plants include: (a) *Drying Cylinders.* Excessive corrosion action, due to the nature of the material and chemical action of the process involved, takes place unless special precautions are taken. One of the most effective remedies, it to make sure that the drying cylinders are completely jacketed over their entire length. (b) *Vapour Removal.* The importance of this has already been stressed. It is necessary to ensure that each cylinder has adequate vapour outlets strategically placed. The vapour piping too, should be of substantial material, well equipped with necessary dampers and cleaning doors. (c) *Scale.* Excessive scale accumulating on the inside of the drying cylinders upsets the temperature control and reduces the quality of the finished product. This can be prevented by ensuring accurate adjustment and setting of the stirrer blades which should be set to work to within a 1/16in. clearance of the cylinder internal wall.

PRODUCTION FLOW CHARTS.

Finally the processes described and illustrated are summarised by the following Flow Charts:—

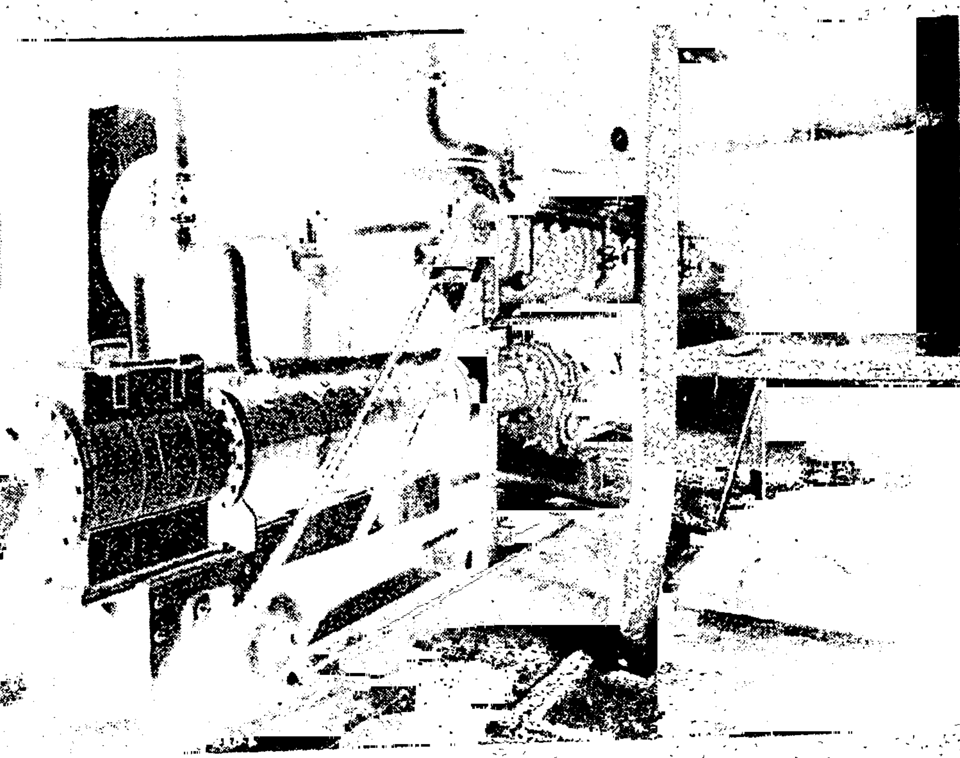


Herring Oil Pressing and Meat Drying Plant



Continuous Type Fish Meal Plant

The "De Laval" Liver Disintegrator



NEW PLANTS FOR LIVER OIL PRODUCTION

By DONALD G. GILLIES

DURING recent years the increased knowledge of the value and use of vitamins has brought very much to the fore the processes for their production. The fat soluble vitamins A and D are now widely used and their main source is from the fish liver oils.

Cod liver oil was of course, the most widely used, but more recently other liver oils having a much higher vitamin potency have been utilised to an increasing extent. These include the liver oils of shark, whale, tuna, halibut, dogfish, etc.

The older methods of recovering the oil from the livers were mainly modifications of the method of boiling with open steam to break up the oil cells and free the oil. The vitamins present in liver oils are, however, readily oxidised and by this method therefore, a certain loss of vitamin potency was inevitable.

Plants recently developed and put forward by the De Laval organisation have eliminated the necessity of boiling by using a special system of mechanical disintegration of the livers followed by centrifugal separation for the recovery of the oil. This method has the advantage over the older methods in that it is continuous in operation, and the time cycle of the oil production is very short.

The De Laval method consists basically of disintegration of the livers in a De Laval disintegrator. This is a compact machine with a feed hopper attached and a device for continuously feeding the livers. The disintegrator housing contains a rapidly rotating drum fitted with a large number of exchangeable thin knives, two stationary knives, which are adjustable in relation to the edges of the rotating knives. The rotating knife edges pass close by the edge of the stationary knives at the rate of 4,200 times per second, which causes such disintegration of the liver that it discharges in the form of a thick cream.

This cream is then pumped into a mixing vessel together with warm water, which serves to free the oil already liberated from the oil cells.

This mixture then passes to the De Laval Centrifuge or centrifuges for the separation of the oil.

It will be seen that with this method the amount of heating is very limited and consequently the oil obtained has a much higher vitamin potency. Further by such complete treatment the yield of oil is considerably greater than by other methods. e.g. when treating fat liver a 98% yield of high grade medicinal oil is obtained, while on lean livers a 95% yield is obtained.

Treatment of the livers in a fresh condition is an essential factor in order to obtain good quality oil. Under storage the livers rapidly deteriorate and the oil loses its value through fatty acid increase, etc.

The compactness of the new De Laval plant is such that installation on board sea-going vessels including trawlers is possible and undoubtedly when the vessel is to be away from port for some little while this is the better procedure to adopt. In other cases where land stations are within easy reach the De Laval plants are installed on shore stations.

For trawler work the disintegrator and one centrifuge only are usually installed in view of the restricted space.

In larger land stations however, the centrifuging is made in two stages.

The mixture of water and disintegrated liver is fed first into a De Laval Nozzle machine, giving a continuous three way separation of solids, liquor and oil.

The oil is fed into a second centrifuge for final purification, while the water discharge can be re-cycled into the mixing tank in order to economise steam consumption.

It will be seen therefore that the whole De Laval plant combines compact construction with high efficiency. A unit comprising one disintegrator and centrifuge is capable of handling 400/500 kgs. of liver per hour, and for larger outputs multiple units can be sold.

THE USE OF CENTRIFUGES IN THE WHALE OIL INDUSTRY.

The whole story of whales and whaling dating back to more romantic times has now developed into a carefully organised industry, playing a big part in the production of the world's demand for oils and fats. For whale oil has now become one of the important basic ingredients of the margarine and compound lard production.

Originally it was necessary for the whale catching vessels to transfer the whale rapidly to the nearest land station, where all the operations for the recovery of the oil, etc., were carried out. There were, of course several disadvantages in this method of handling. Firstly during transport the carcass rapidly deteriorated. Secondly the oil was settled in large tanks to remove moisture and impurities, and during this prolonged treatment, due to contact under heat with water and fine solids the fatty acid content of the oil increased and a darker oil resulted. A further disadvantage of this method was the high cost of handling. Coupling all these facts together resulted in an approach to the problem from a different angle.

In 1924 the De Laval organisation did much to revolutionise the whole industry by the introduction of the high speed centrifugal separator for the purification of whale oil. This gave a

compact plant which cut out the necessity of the large settling tanks of the land stations, and which could readily be installed on board sea-going vessels. In other words the factory ship was developed whereby the whales could be handled in a relatively fresh condition very soon after being caught. It was proved even at an early date that the oil treated on board the factory ships by De Laval Oil Centrifuges, was purified to such an extent that it would keep in good condition indefinitely. Here then was the method by which good quality oil could be obtained, and by which heavier land station costs could be reduced and an oil of better quality than the "land-settled" could be produced.

This method assisted very greatly in the development of the modern fleet of factory ships, much depleted during the war, but now being rapidly rebuilt. The land station is now therefore, to a large extent, eliminated, and the large factory vessel, with its fleet of attendant catchers can sail from and return to the ports which are the ultimate destination of the crude oil.

WHALE OIL PURIFICATION

De Laval have developed during more recent years special high capacity centrifuges for the purification of Whale Oil. The general design follows the well-known practice of high speed disc type bowls, which greatly increases the separation efficiency. This feature was originally introduced into De Laval machines over 50 years ago, and continued improvements in design and performance have resulted in the latest Whale Oil Purifier (type B.1910.CV) which can handle a continuous output of 6 tons per hour. As an indication of the size of a modern factory ship installation it is interesting to note that the "Balaena" had 13 of these machines installed.

The general arrangement of the whale oil purification system is as follows: The crude oil from the boilers is run into one of two buffer tanks. These tanks are arranged with float "Take-off" devices, through which the upper layers are fed to the Whale Oil Purifiers. Coarser solid settles and is drawn off independently. The purified oil from the centrifuges is then either pumped or run by gravity direct into the storage tanks. A typical installation of the Whale Oil Centrifuges is shown in the accompanying photograph.

GLUE WATER PROCESSING

Originally the glue water resulting from the pressure cooking of the bones, etc., was discarded into the sea. In this way however, a quantity of oil present in the glue water was lost. It is now therefore, the generally accepted practice to instal a second battery of centrifuges for the de-oiling of the glue water. From the centrifuge point of view this problem is rather different to the straight oil purification, as the liquor resulting from the pressure cookers contains a considerable percentage of finely dispersed protein matter, etc.

The standard 'purifier' bowl is not designed for handling a high percentage of solid, as the solids extracted are held in the centrifuge. Therefore on glue water it would be necessary to stop frequently for cleaning. For handling a problem of this kind therefore the special 'De Laval' Nozzle type bowl was developed. In the periphery of this bowl are placed a number of small nozzles, the size of which can be adjusted as required. Through these nozzles the solids separated discharge continuously, and so uninterrupted operation of the machins is obtained. This special centrifuge is therefore a continuous three-way separator. Sludge is discharged through the nozzles, water through the heavy liquid discharge and oil through the light liquid discharge.

The process adopted is as follows: The liquor from the pressure cookers is discharged into a blow tank. From here the liquor is first pumped to De Laval vibrating wire mesh screens in which all the coarse solid matter is removed. This is a necessary step when using a 'Nozzle' machine, otherwise large solid particles would choke the discharge nozzles and stop the operation of the machine. The screened liquor and fine solid collects in a hopper from where it is pumped to a buffer tank for the centrifuge feed. The liquor then passes into the battery of De Laval Nozzle machines from which the sludge and water are fed away. The separated oil from these machines is then pumped into the feed tank for the Whale Oil Purifiers, where, of course, it receives final purification before storage. The throughput capacity of the De Laval Nozzle Separator (Type SVK 5) is 1,250 g.p.h. and on the 'Balaena' nine of these machines are installed.

We have now examined the two main functions of the De Laval centrifuges on the factory ship as far as the whale oil is concerned. It is perhaps also worth while recording that centrifugal separators are also installed for the purification of fuel and lubricating oil for the diesel generators.

LAND APPLICATIONS

It will now be as well to examine the progress of the crude oil once it is delivered from the factory ship to port. The oil at this stage is not edible as it contains free fatty acids and also unpleasant oderiferous bodies, etc.

To convert it into an edible product it is therefore necessary to give the oil a refining treatment. Centrifugal Separators also play an important part in the modern operation of this process.

The first step is one of neutralisation. The crude oil was originally treated by the batch gravity settling system, which has now been superseded, to a large extent, by centrifugal methods working either on a semi-continuous or continuous system. In the former case the crude oil is pumped into one of two neutralising tanks, where it is heated. Agitators are provided and caustic soda solution then sprayed in, in sufficient quantity

to neutralise the fatty acids. Soap results from the combination of the acids and the caustic soda, and immediately the reaction is complete the whole batch of oil and soap mixture is run through a battery of De Laval Soap-Stock Separators. These are special centrifuges, again following the disc design, which maintain a continuous separation of the soap from the oil, and the capacity of each machine is of the order to 750 g.p.h. The separated oil is then pumped from the soap-stock separators to the washing system where it is given a hot water wash in order to remove the last traces of soap, which are mainly in solution in the oil from the first machines. The mixture of water and oil is then separated in a battery of De Laval Wash Water Separators.

The advantages of this system are considerable. The refining loss is considerably lower due to the efficient de-oiling of the soap in the centrifuges. The long settling periods are eliminated and the whole installation is very compact. By using only two neutralising vessels the centrifuges may be kept operating continuously.

In some fatty oil refining plants the caustic and oil are also mixed continuously making the whole operation continuous.

The washed oil is then dried, deodorised and in most cases the oil is hydrogenated to increase the melting point and give a hard fat for margarine and compound lard.

CONCLUSIONS

It will be seen from the foregoing brief remarks that the use of high speed centrifuges plays no small part in the production of whale oil. Continued research and process development work by the De Laval organisation has produced machines of special design to meet these requirements.

As far as the factory ships are concerned the success of the equipment is proved by the evidence of installations in all the modern whale boats recently put into service and now building. The 'Balaena' has the world's largest centrifugal separator installation afloat at present having twenty-five De Laval machines on board.

In the land refineries there is a continued trend towards the utilisation of centrifugal methods for refining the oils, and the economical savings have been well proved.

Centrifugal methods are also now applied to an increasing extent in the recovery of herring oil, for the recovery and purification of fish livers, for the purifying of canning oil, etc.

Further the present general world interest in the expansion of industries connected with fish bye-products gives an ever increasing field for the use of high efficiency centrifuges. As a typical example the production of protein can be quoted in which the liquors at various stages are clarified by centrifuges.

FISH AND FISHERIES ON POSTAGE STAMPS

SOME EXAMPLES DESCRIBED AND ILLUSTRATED

By Eric Lorraine Adlem

MANY postage stamps bearing fish and fishery designs have been issued in all parts of the world in recognition of the importance of this vital food industry, and of the hard tasks performed by the thousands of workers connected with the trade, and it is only fitting that this token of esteem portrayed on postage stamps should not be allowed to pass without mention, for the designs are certainly of interest to all engaged in the handling of fish.

Although restrictions on space will not permit me to include in this short survey all the specimens of this nature which have been issued to date, I have endeavoured to present some of the outstanding designs in order to indicate the wide range which exists.

Readers will agree that the artists concerned have produced a fine array of pictorial studies of which we can be justly proud.

British Empire Designs.

It is interesting to note that stamps of the British Empire showing fish and fishing are just as numerous as those issued by foreign countries.

A rather unusual design of British Guiana, which first appeared on the 2-cents (brown) denomination released in 1931 to commemorate the centenary of County Union, portrays an Indian shooting fish with a bow and arrow. This same design was again featured in 1934, and is also to be found on the current 6-cents (blue) value.

A fine study of the Caribbean dolphin is illustrated on the ½d. (green) and 1s. (brown) denominations of the current series of Cayman Islands postage stamps.

Newfoundland has produced several stamp designs in honour of its fisheries, and two striking examples are reproduced on the opposite page. The 1-cent value, showing codfish, was released in a series circulated in 1932, and two printings were undertaken—one in grey and the other in green. The 48-cents (brown) appeared in the same series, and this portrays the fishing fleet leaving for the Banks. It is worth noting that this Dominion's first fish design, that of a single codfish, appeared as early as 1866

on the 2-cents (green) denomination in the first series of perforated stamps.

New Zealand's contribution is that of a swordfish leaping out of the ocean on the 5d. (blue) value, released in 1935.

Other Specimens

Chile's fishing industry has received postage stamp publicity on a number of occasions. A good example is that of the 1-peso (orange) value of 1938 which depicts a fishing smack.

In 1931, Iceland released a set of six values showing a codfish

on three of the denominations—as shown on the 1-eyr (blue) stamp reproduced here—and herring on the remainder.

The art of spearing fish, as practised in the Oceanic Settlements, is portrayed on eight values of these French islands' stamps, of which the 1-cent (black) is illustrated.

Saint Pierre and Miquelon, a group of French islands off the

South coast of Newfoundland, can undoubtedly claim to have produced more stamps depicting the fishing industry than any other foreign country. Here, the postal authorities commenced in 1909 with a fisherman design on seven denominations, and a fishing boat on another six values. These continued to appear in different printings until 1931. Then, in 1932, the fishermen holding net with map in centre design (as illustrated) was produced on several stamp values. Two other pictures of a lighthouse and a fish trawler adorn the rest of this series.

Current Postage Due stamps of this country, first released in 1938, also show a well drawn little picture of a codfish against the background of a fishing vessel's mast-head.

An excellent picture of a fisherman holding up a prize catch is shown on the 15-zloty (blue) value in a new series of industrial stamp designs released in Poland.

FISHERY SCHOOLS AND RESEARCH INSTITUTES

IN all the leading countries of the fishery world research is carried on. Private interests, trade associations and governments, jointly or severally support research institutes and laboratories to investigate problems, and experiment on solutions connected with fishery and the processing of fish. Valuable work has been done in this field by European countries, the U.S.A., Canada, the U.S.S.R., and before the war, in Japan.

An international organisation, the *International Council for the Exploration of the Sea*, has correlated much of the research work over a wider field and its activities which include conferences and publications, have been of great benefit. In view of the overfishing problem the work of this council is of practical, as well as of scientific importance. The following data should be noted for reference:

International Council for the Exploration of the Sea

Address: Postbox 20, Charlottenlund, Denmark.

Telephone: Helrup 1865.

Telegraphic Address: Merexploration.

President: Prof. J. Hjort.

Geneal Secretary: H. Blegvad.

A great amount of useful and interesting work has been done by the various Research organisations and Laboratories in America, both on the Atlantic and the Pacific seaboard.

In Great Britain the work of the various institutes was, of course, largely restricted by the war, but now they are almost back to pre-war standard.

The Ministry of Agriculture and Fisheries in the U.K. maintains the *Fisheries Laboratory* at Lowestoft under Mr. Michael GRAHAM where marine investigations are carried on. Then there is the *Torry Research Station* (of the Food Investigation Board, Department of Scientific and Industrial Research), 11, Baxter Street, Aberdeen. Superintendent: George A. REAY, M.A., B.Sc., Ph.D. It carries on almost every branch of research on fishery and fish processing. The other institutions are:

Plymouth Marine Laboratory of the Marine Biological Association of the U.K., Citadel Hill, Plymouth. The principal is Frederick Stratten Russel, D.S.C., D.F.C., F.R.S. The result of its work has been published in various issues of its Journal. Much work has been done investigating the utilisation of seaweed.

The *Dove Marine Laboratory*, Cullercoats (part of King's College, Newcastle-upon-Tyne), worked for some time on the local marine fauna, the herring and salmon fisheries and the sensory physiology of fish.

Department of Oceanography, University College, Hull. Much work was done in connection with plankton observation. The results and other fruits of its work have been published in the series "Hull Bulletins of Marine Ecology."

Port Erin Marine Biological Station (University of Liverpool) devoted itself during the war to research in connection with the local fishing industries.

FISHERIES RESEARCH BOARD OF CANADA

This Board, established by Act of Parliament of Canada, operates five principal Stations for fisheries investigation. Three of these are Biological Stations for study of the living fish in the water and of the conditions under which they live in order to solve the problems of the location, abundance and capture of the fish. These are located at St. Andrews, N.B., on the Atlantic coast, at Winnipeg, Man., in the middle of the country and at Nanaimo, B.C. on the Pacific coast. There are also three Experimental Stations for investigating the problems of the handling of fish, particularly in connection with decomposition of the fish and preservation by salting, drying, smoking, freezing and canning. Two of these are on the Atlantic coast at Halifax, N.S. and Grand River, P.Q., and one is on the Pacific coast, at Vancouver, B.C.

Courses for fishermen have been conducted, but the main purpose of the Board and its Stations is research rather than education. The fishing industry is represented on the Board by two members for the Atlantic and two for the Pacific coast to ensure that the problems of the industry are understood and receive attention. The Board publishes (1) an Annual Report giving the main results of its investigations during the year, (2) Bulletins giving authoritative accounts of particular subjects either for the general fisheries public or for specialists, the largest of which have been a monograph on marine animal oils and a handbook of the marine fishes of the Pacific coast, (3) a Journal containing scientific contributions to knowledge of principles for accurate prediction to make practice successful, and (4) Progress Reports for each coast to acquaint the industry with some aspects of the investigations undertaken.

Recent investigations have included the following: At St. Andrews, on the lobster, oyster, clam, groundfish, herring, smelt, trout and salmon fisheries. At Halifax, on deterioration in quality, freezing and refrigerated storage, tunnel smokehouse and air drying unit. At Grand River, on sanitation of fish plants and fishing vessels and artificial drying. At Winnipeg, on quality of whitefish and the goldeye fishery. At Vancouver, on railway refrigeration cars, nutritive value of fish, constituents of fish oils, germicidal sprays and speciality products. At Nanaimo, on the herring, pilchard, sockeye salmon, other salmon and trawl fisheries.

FISHERY SCHOOLS

Education is a more local enterprise, though the governments of various countries are taking great interest in the training of

fishermen, e.g., in Great Britain. Here a Committee composed of all fishing interests, public bodies and the government, has worked out an "Outline Plan for Post-War Recruitment and System of Apprenticeship to the British Trawling Industry." This report was published by the Technical Education Committee of the Fishing Industry (Ministry of Transport, Berkeley Square House, London, W.1) and is probably the most comprehensive outline of education in the fishing industry. Another report is shortly to be completed on education for the herring and inshore fisheries.

There are two famous schools in England, the Grimsby Nautical School and the Fleetwood Navigation School.

The Grimsby school, started in 1897, had 1,642 students last year with a staff of six permanent and six part-time teachers. The Principal is Capt. F. E. TOWNEND, M.B.E. The Fleetwood school is run by the Lancashire Education Authority, classes being arranged to suit the convenience of serving seamen. The Principal is Capt. W. M. F. MACFARLANE, F.R.A.S., A.I.N.A.

A detailed description of a Canadian Fishery School will be found in the following pages.

NEW CURRICULUM IN AUSTRALIA

As a result of experience gained during the first course at the Commonwealth Fisheries School at Cronulla, New South Wales, some changes have been made in the syllabus and an important change has been made in the duration of the course.

Both changes came into effect at the beginning of the second course last month with a full enrolment of trainees drawn from all States.

During the first course trainees were required to do four months at the School and then to go into subsidised employment in the fishing industry to attain further practical experience of everyday work. However, difficulty was experienced in placing the trainees in subsidised employment, partly because fishing in Australia is mostly operated by one-man boat owners, by crews who are joint owners of their boat, or by owners with crews on a share basis somewhat similar to share farming.

It was therefore decided, and approved by the Central Reconstruction Training Committee, that the Fisheries School training course should be extended from four months to thirty weeks and that the period of subsidised employment should be abolished. The thirty weeks' course will enable trainees to have plenty of practical experience so that at the end of it they should be quite capable of taking their place in the fishing industry.

To assist in achieving this objective some of the theoretical instruction given during the first course, for example, in Fisheries Biology and Fishery Economics, will be reduced to provide more time for practical work and operating on the School's two trawlers.

A VENTURE IN FISHERIES EDUCATION

THE SCHOOL OF FISHERIES OF STE. ANNE, P.Q. OF CANADA

THE School of Fisheries, like other educational institutions in Quebec, had a humble beginning. It began in 1928 by a very short course on commercial fisheries, introduced in the curriculum of the School of Agriculture in order to increase the efficiency of the graduates from the fishing areas of the province of Quebec.

Ten years later, in 1938, a fully fledged school of fisheries emerged from this pioneering step in fisheries education. It was created by an Act of the Provincial Legislature and organized, housed and administered by the School of Agriculture.

This particular set up was, at the time, believed unique and novel. It is not. In Japan, as disclosed since the Allied Forces occupation, there are three schools of Fisheries integrated in the faculties of Agriculture of the universities of the country. And the fact that before the war, the fishing industry of Japan ranked first in the world, both in value and output, speaks rather high for its fisheries education system.

Both the Canadian and Japanese institutions have research and fisheries engineering instruction on their programme of activities, but the Canadian School goes a long step further with courses of technical and professional education for young fishermen and with an extension service, *le Service Social-Economique*, to promote adult education and organize co-operative associations in fishing communities.

For this, the School of Ste. Anne may rightly be, and has many times been, called unique.

At the first Conference of the Food and Agriculture Organization (F.A.O.) in Quebec in 1945, the Fisheries Committee made the following recommendation:

> "F.A.O. should therefore encourage the establishment of fishery schools and suitable fishery courses at appropriate institutions. As in the case of Agricultural schools in many countries, these could serve as training centres for persons specializing in fisheries. The schools should also be centres for specialized fisheries courses and for extension works for dissemination of information to fishermen and shore workers on all phases of production, processing and distribution."

At the time, was the Committee aware of the fact that such a School existed already and that in Canada, at Laval University, Quebec, their wish had to the fullest extent and in the most minute details, materialized eight years before it was even expressed? Or rather were they not aware of all this?

Research is the *sine qua non* of an educational institution and the School has begun by perusing the treasures; specialized research laboratories have already accumulated and are constantly increasing. The regular engineering course has a four year curriculum, thus divided: the two junior years devoted to basic sciences, mathematics, physics, chemistry, biochemistry, biology and economics. The two senior years devoted to applied sciences. Natural history of commercial fish, shell-fish and mollusks, hydrology and oceanography, navigation and fishing are leading courses. Applied bio-chemistry, bacteriology and technology of refrigeration, canning and curing fish and manufacture of by-products in the fishing industry have their share of the programme. Finally the conservation and management of fishery resources, organization and scientific management of fishing and fishery enterprise and co-operatives account for a good third of the two thousand hours or so devoted to applied sciences.

This extensive programme in Fisheries Applied Economics is a special feature of the School of Fisheries. It was given as an appropriate answer to a need and moreover it is in full accord with the definition of engineering as given by a distinguished English engineer as being *"the art of the economic application of science to the industry."* Another special feature of Ste. Anne is the practical training of future graduates. In fact these are required to spend three months each summer in various capacities in the industry. Some go as common and skilled labourers in fish processing plants, others as salesmen, clerks of junior accountants in wholesale and retail shops while the seniors go as scientific assistants in laboratories or at sea on oceanographic cruises or even as propagandists is adult education for the *Service Social-Economique*. At the end of their course, they have thus spent nine months in the industry, the equivalent of a full academic year.

The entrance requirements are the same as for civil engineering, law and other professions; the B.A. of our classical college or equivalent credits from other institutions of good standing.

A project of a school of Fisheries in Porto Rico never materialized because the promoters could not gather a sufficient teaching staff. The School of Ste. Anne took this hurdle by bringing its personnel from three sources at the same time: professors of the faculty of Agriculture, visiting and resident professors. Basic sciences being alike in agricultural and fisheries tuition, both groups of students follow the various courses in common and one professor only, the professor of the faculty of Agriculture, is thus needed.

For many of the subjects taught in applied sciences, the School calls upon specialists from outside and for the duration of their particular course only. These come from fisheries research laboratories, other universities, consultant offices and from the industry itself. Useless to add here that they are competent since on the list of these regular visiting professors, appear the names of Drs. D. K. Tressler in refrigeration, E. Hess and H. Fugers in canning and curing and many others of equal scientific standing.

Such an arrangement enables the School to keep its staff of resident professors at a minimum, a necessity borne of it budget limitations. However these residents include men with European educational background. One of them is a doctor of science of the University of France while another was a Ph.D. of Cambridge, England. The Oceanographer of the School, Cdant Lucien Beauge, was formerly with the "Office Scientifique et Technique des Pêches Maritimes of France." The allover list of the professors of the school of Fisheries of Ste. Anne bears thirty names.

Materializing such a programme and gathering such a staff has been quite a task. Thus it was very gratifying to have this achievement officially recognized by the Fishering Gazette of New York.

Founded in 1939, the School of Fisheries of Ste. Anne is not yet ten years old. However it has some accomplishments to its credit. To higher studies and professorship, to public administration and mainly to the fishing industry, it has given many graduates, many of them already in key positions in the industry. Over four hundred young fishermen have enlisted for the course of professional training and notwithstanding budget limitations, Cdant Beauge has given the fisheries of Quebec their first fishing maps and is establishing progressively the cycle of migrations of codfish in the gulf St. Lawrence.

The professors of the School have been pioneers in the modernization of the Quebec fishing industry, one of them building and operating the first freezer of the chain of forty, of which the province of Quebec is now justly proud. They contribute largely to scientific magazines, newspapers, radio programmes. Many books and booklets have already been published with their names on the cover. Among the books, may we mention two of Cdant Beauge: *Manuel du Pêcheur* and *Manuel des Grandes Pêches Maritimes* and one of Prof. Louis Berube: *"Coup d'Oeil sur les Pêcheries de Québec."*

But in the field of Extension, the Service Social-Economique, leads by a considerable margin. Through its dynamic action and policy and use of all the known means of spreading propaganda and education (study clubs, field days, conferences, meetings, radio, newspapers), fishermen have organized credit unions, co-

operative stores, fish production syndicates and even forestry co-operatives. But the gem of all is the Quebec United Fishermen, a federation organized by the service in 1939 of forty-five local fishermen's co-operatives, grouping more than four thousand fishermen and handling the two thirds of the whole production of the fisheries of the province of Quebec. The *Service-Social-Economique* edits its own newspaper "*A Pleines Voiles.*"

Many references have already been made to budget limitations. Not many people know that the overall budget of the first year of the School of Ste. Anne was constituted by a grant of $25,000 from the government of the province of Quebec. Fortunately things have eased up, the government of Canada helping with a grant to the Extension Service of the School. However, for 1946 the overall budget was yet below the fifty thousand dollar line.

The School of Fisheries owes much to its sister institution, the School of Agriculture and had to put in daily practice in what it teaches its students in Economics of Engineering, "to accomplish with one dollar what anyone could do for no less than two."

Organisations and Trade Associations
of the
World's Fisheries

AUSTRALIA

United Fishermen's League

Address: 7, Municipal Fish Markets, Sydney, N.S.W.
Telephone: M.A. 4721.
President: W. T. Paddon.
Secretary: J. H. Facey.

CHINA

Foreign Trade Association of China

Address: Room 338, 170, Kiangse Road, Shanghai O.
Telephone: 13417.
Director and Chief Executive Secretary: C. C. Chang.

GREAT BRITAIN

British Federation of Fish Importers

Address: 15, Park Row, Leeds, 1.
Chairman: Andrew Wright.
Secretary: W. A. R. Speight.

Eastern Sea Fisheries Joint Committee

The object of this association is fishery protection
Address: 48, King Street, King's Lynn.
Telephone: 3183-4.
Clerk and Chief Fishery Officer: R. Taylor.

Grimsby Exchange Limited

This is a trading company that provides services for trawler owners at the Port of Grimsby.

Address: Fish Dock Road, Grimsby, Lincs.
Chairman: Jack Croft Baker.
Vice-Chairman: Herbert Walter Crampin.
Secretary: John Hall.

Grimsby Trawler Owners' Association

This Association is the Trade Association of the Port of Grimsby.

Address: Fish Dock Road, Grimsby, Lincs.
Chairman: Jack Croft Baker.
Vice-Chairman: Herbert Walter Crampin.
Secretary: John Hall.

Herring Industry Board

Address: 20, St. Andrew Square, Edinburgh 2.
Chairman: Sir F. A. Bell, Kt., O.B.E., M.C.
Secretary: T. H. Wilson.
Telephone: 27208.
Telegraphic Address: "PISCINA, Edinburgh."

Hull Fish Merchants Protection Association Ltd.

Address: St. Andrews Dock, Hull, E. Yorks.
Telephone: 37767-8.
Telegraphic Address: "Piscator."
President: R. Willey.
Vice Presidents: L. T. Field and J. N. Colley.
Secretary: J. E. Plowman.

Hull Fishing Vessel Owners' Assn. Ltd.

Address: St. Andrew's Dock, Hull.
Telephone: 37657-8.
Telegraphic Address: "Owners Hull."
President and Chairman: T. Hudson, M.B.E.
Vice President: H. Wright.
Secretary: E. Thrale, A.C.I.S.

Isle of Man Fish Curers' and Fish Merchants' Association

Address: Isle of Man Bank Chambers, Douglas, Isle of Man.
Telephone: Douglas 6.
Chairman: A. D. McEvoy.
Vice-Chairman: G. Rogers.
Treasurer: J. Curtis.
Executives: D. H. Phillips, F. C. Moore, E. Eddy, P. O'Hanlon,
Trustees: G. A. Deverau, H. Faragher.
Secretary: Albert Hill, F.S.A.A., A.C.C.A.

Swansea Port Wholesale Fishmerchants' Association

This Association is affiliated to the Federation of British Port Wholesale Fish Merchants' Associations.
Address: 66, Exchange Buildings, Swansea.
Telephone: 2823.
Chairman: H. Leadbetter.
Vice Chairman: E. N. Treweek.
Hon Treasurer: W. J. Hughes.
Secretary: W. E. James.

NETHERLANDS

Bedrijfschap Voor Visscherijproducten

Central Organisation of the Fishery Industry and Fish Trade.
Address: Wassenaarscheweg 20, Gravenhage.

NEWFOUNDLAND

Newfoundland Fisheries Board

Address: St. John's, Newfoundland.

NORWAY

Association of Fresh Fish Exporters

Address: Aalesund.

Norges Torfiskeksportorers Landsforening

This Association was established in order to safeguard the interests of Stockfish Exporters, when the various markets were centralised some years ago.

Address: Postboks 151, Bergen.

Chairman: Trygve Ritland, Bergen.

Members: N. Anthonisen, Bergen, Carl Konow, Bergen, A. Aarsaether, Aalesund, Rolf Jentoft, Ballstad, Leif Johansen, Stamsund, Ing. Valle, Vardo, Trygve Nissen, Hammerfest.

Managing Director: Ove Roll.

Telephone: Central 17663.

Telegraphic Address: " Stokfisk."

UNITED STATES

National Fisheries Institute, Inc.

This is a trade association, a private corporation not for profit, organized under laws of the State of Delaware.

Address: Victor Building, 724 Ninth Street, N. W. Washington D.C.

Telephone: National 2216.

President: O. L. Carr.

Secretary: W. C Eardley.

Vice President: F. M. Bundy, Jerome W. Kiselik, Carlton Crawford, B. W. Shipman, E. A. Ruthford, Arthur Jarrell

Fish Distributors Cooperative Association, Inc.

Address: 308 West Washington Street, Chicago 6, Illinois.

Telephone: Franklin 4267, Randolph 2275.

Executive Secretary: Chas. W. Triggs.

Members: A. E. Burhop, Co., Chicago, Fulton Smoked Fish, Co., Chicago, Jarrell & Rea, Pittsburgh, Knapp Brothers, Pittsburg, Meltio Seafood, Co., St. Louis, Wm. M. McClain, Inc. Philadelphia, Mid Central Fish Co., Kansas City, Robbins, Inc., Chicago, W. T. Smith Company, Chicago, Wicker Fish and Poultry Company, Dallas.

Associated Salmon Packers' Association

Address: 2502 Smith Tower, Seattle, Washington.

California Fish Canners Association, Inc.

Address: 501 S. Seaside Avenue, Terminal Island, California.
Exec. Vice President: R. H. Beaton.

Fishing Vessel Owners' Association

Address: Pier 8, Seattle, Washington.
Secretary: Hardol Lokken.

Pacific Herring Packers' Association

Address: 200, Bell Street Terminal, Seattle, Washington.

Trolling Vessel Owners' Association

Address: Box 297, Tacoma, Washington.

Wholesale Fish Dealers' Protective Assn.

Address: Dock Street Fish Market, Philadelphia, Pa.
Pesident: J. Irvine Edge.
Secretary: Geo. F. Folcher.

Trade Journals of Interest to the Fisheries Industry and Fish Trade

AUSTRALIA

Fisheries News Letter

Published monthly by the Commonwealth Fisheries Office, Box 2595, G.P.O., Sydney.

BELGIUM

Zeevisscherij

Aartshertoginnestraat, 44, Ostend. (Weekly).

Het Nieuw Visscherijblad

Nieuwpoortsteenweg, 44, Ostend. (Weekly).

CANADA

Canadian Food Industries (Monthly)

Federal Publications, Ltd., Gardenvale, Que. Journal of the Canadian Food Industries. Subscription rate: $2 per year in Canada.

Commercial Fisherman

Published on 1st and 15th by Pilot Publishing, Co., Ltd., P.O. Box 248, Vancouver, B.C. for Pacific Coast fishing industries of Canada. Established 1935. Managing Editor: Rolph Bremer, B.A.

Western Fisheries

Published by Roy Wrigley Printing & Publishing Co., Ltd., 818, Richards Street, Vancouver, B.C. A monthly magazine covering British Columbia's Commercial Fisheries.

DENMARK

Dansk Fiskeritidende

Editor: F. L. Ingemann, Aertemarken 75, Soborg.

Vestjydsk Fiskeritidende

Finsensvej 25, Esbjerg.

European Fishimport and Fishexport

Published six times a year by the Exporters Information and Advertising Service, 67-69, Kobmagergade, Copenhagen.

FRANCE

La Peche Maritime

190, Boulevard Haussmann, Paris VIII.

GREAT BRITAIN

Fish Trades Gazette

49, Wellington Street, London, W.C.2. Weekly journal for the Retail Trade.

Fishing News

Broad Street, Aberdeen. Weekly.

ITALY

Il Commercio Della Pesca

Via del Prefetti N.8, Rome.

NETHERLANDS

De Visserijwereld (weekly)

Nobelstraat 27a, The Hague. Editor: F. Spittel.

NEWFOUNDLAND

Newfoundland Fishermen's Advocate

Port Union.

NORWAY

Fiskets Gang

Weekly intelligence journal of the Norwegian fisheries, etc. Published by the Director of the Norwegian Fisheries (Fiskeridirektoren) Bergen. Price: Annual Subscription kr. 16— (abroad).

Tidsskriftfor Hermetikindustri

(Norwegian Canners Export Journal), Stavanger. Established 1914. Published monthly on behalf of the Norwegian Canners National Association, and also giving the reports from the Research Laboratory of the Norwegian Canning Industry. Subscription rates: Norway N. Kr. 12, a year, all other countries N Kr. 18 a year.

POLAND

Przeglad Rybacki (monthly) ul.

Zajaczkowskiego 9, Warsaw.

Archiwum Hydrobiologii I Rybactwa (three monthly)

Editor: Morskie Laboratorium Rybackie, Gdynia.

Industrias Pesqueras

Published by Servicios Industriales Pesqueros, S.A. Policarpo Sanz, 21-2 Vigo.

Nautilus

Principe, 9, Apartado 658, Madrid.

Vida Maritima

Calle de Alcala, 19, Madrid. Published every fortnight since 1943.

UNITED STATES

Fishery Gazette

461 Eighth Avenue, New York 1, N.Y. A journal devoted to market surveys, fishing vessels, shore plant machinery, equipment and supplies. Available on request. (Monthly).

Southern Fisherman

Pan-American Bldg., New Orleans, La.

Atlantic Fisherman

Goffstown, New Hampshire.

Pacific Fisherman

71, Columbia St., Seattle, Wash.

English	*Scientific*	*Francais*	*Deutsch*
Anchovy	Engraulis encrasicholus	Anchois	Sardelle
Angelfish	Rhina squatina	Ange	Meerengel
Angler	Trachinus vipera	Petite Vive	
Bass	Labrax lupus	Barcommun	Barsch
Bream	Abramis brama	Breme	Brasse
Brill	Rhombus laevis	Barbue	Glattbutt
Carp	Cyprinus carpio	Carpe	Karpfen
Catfish	Anarrhichas lupus	Anarrhique loup	Katfisch
Coalfish	Gadus virens	Colin	Kohler
Cod	Gadus morrhua	Morue Cablian	Dorsch
Conger Eel	Conger vulgaris	Congre	Meeraal
Crabs		Crabes	Krabben
Dab	Pleuronectes limanda	Limande	Scharbe
Dogfish	Scylliorhinus Stellaris	Petite Rousette	Grossgefleckter Katzenhai
Eel	Anguilla vulgaris	Anguille	Aal
Flounder (See also Witch)	Pleuronectes flesus	Flet Commun	Flunder
Fluke (See also Flounders)			
Gurnard (See also Gurnet)			
Gurnet	Trigla Gern	Gornoud	Knurhahn
Haddock	Gadus aeglefinus	Aeglefin	Schellfisch
Hake	Merluccius vulgaris	Merlu	Seehecht
Halibut	Hippoglossus vulgaris	Flétan	Heilbutt
Herring	Clupea harengus	Hareng	Hering
Lemon Sole	Pleuronectes Microcephalus	Limande-Sole	Rotzunge
Ling	Molva vulgaris	Lingue	Lengfisch
Lobster		Homard	Hummer
Mackerel	Scomber scomber	Maquereau	Makrele
Megrims	Arnoglossus laterna	Cardine	Schorffisch
Monkfish	Lophius piscatorius	Baudroie	Seeteufel

of Fish Names

Norske	*Dansk*	*Svenska*	*Nederlands*
Ansjouis	Ansjos	Ansjouis	Anchovis
			Zee Angel
		Lilla Fjarsing	Kleine Pieterman
Havaborre	Bars	Hafsaborre	Baars
Brase	Brasen	Braxen	Brasen
Sletvar	Slethvar	Slathvarf	Griet
Karpe	Karpe	Karp	Karper
Stenbid	Söulv	Vanlig Hafkatt	Zeewolf
Sei	Sej	Sej	Koolvisch
Torsk	Torsk	Torsk	Kabeljauw
Havaal	Havaal	Hafs-al	
	Krebber		Krabben
Sandflyndre	Ising	Sandskadda	Schar
		Storflackig Rodhaj	
Aal	Aal	Al	Paling
Skrubben	Skrubbe	Flundra	Bot
Knor	Knur	Knot	Kl. Poon
Hyse	Kuller (Hyse)	Kolja	Schelvisch
Lysing	Kulmule	Kummel	Stokvisch
Kveite	Helleflynder	Helgeflundra	Heilbot
Sild	Sild	Sill	Haring
Lomre	Rodtunge	Bergskadda	Tongschar
Lange	Lange	Langa	Leng
	Hummer		Kreeft
Makrel	Makrel	Makril	Makreel
Tungevar		Tungehvarf	Schurftvisch
Bredflab	Bredflab	Merulk	Zeeduivel

English	*Scientific*	*Francais*	*Deutsch*
Mullet (Grey)	Mugil capito	Muge Capiton	
Mullet (Red)	Mullus surmuletus	Surmulet	Streifenbarbe
Norway Haddock	Sebastes norvegicus	Eglefin de Norvege	Rotbarsch
Oyster		Hurtre	Auster
Perch	Perca fluviatilis	Perche	Fluss Barsch
Pike	Esox lucius	Brochet	Hecht
Pilchard	Clupea pilchardus	Sardine	Sardine
Plaice	Pleuronectes platessa	(Carrelet) Plie	Scholle
Pollack	Gadus Pollachius	Merlan Jaune	Pollack
Prawns		Grande Crevettes	Kraffe
Ray (see Skate)			
Roach	Leuciscus Rutilus L.	Rosse (Garden Ordinaire)	Weissfisch Plotze
Saithe (see Coal Fish)			
Salmon	Salmo salar	Saumon	Lachs
Scaldfish	Arnoglossus laterna	(See also Megrim)	
Sea Bream	Pagellus centrodontus	Rousseau	Nordischer Meerbrassen
Shrimps		Crevettes	Garnelle
Skate	Raja batis, etc.	Raie Batis	Roche Glattcoche
Smelt	Osmerus eperlanus	Eperlan	Stint
Sole	Solea vulgaris	Sole	Seezunge
Sprat	Clupea sprattus	Esprot	Sprott
Sturgeon	Acipenser sturio	Esturgeon	Stohr (Stor)
Tench	Tinca vulgaris	Tanche	Schleihe
Trout	Salmo fario	Truite	Bach Forelle
Turbot	Rhombus maximus	Turbot	Steinbutt
Tunny	Thynnus vulg.	Thon commun	Thunfisch
Whitebait	Clupea sprattus		
Whiting	Gadus merlangus	Merlan	Wittling
Witch	Pleuronectes cynoglossus	Plie Cynoglosse	Flunder (Hundszung
Wolf fish	Anarrhicus lupus	Lompe	Seehasen

of Fish Names—*Continued*

Norske	*Dansk*	*Svenska*	*Nederlands*
Kelt	Tunnlappade	Multe	
	Mulle	Mullen	Koning v.d. Poon
Uer	Rodfisk	Store Kungfisk	Roodbars
			Oester
Aborre	Aborre	Abborre	Baars
Gjedde	Gjedde	Gadda	Snoek
Sardin	Pilchard	Sardin	Pelser
Rodspaette	Rodspaette (Flyndre)	Rodspätta	Schol
Lyr	Lubber	Lyr	Pollak
	Reker		Garualen
Mort	Skalle	Mort	Voorn (Blankvoren)
Lax	Laks	Lax	Zalm
		Flackpagelle	Roode Zeebrasen
	Rajer		Garnalen
Glat Skate	Skade	Slattrocka	Rog (Vleet)
Nors	Smaelt	Nors	Spiering
Tunge	Tunge	Tunga	Tong
Brisling	Brisling	Skarpsill	Sprot
Stor	Stor	Stör	Steur
	Suder	Sutare	Zeelt
Orret	Orred	Forell	Forel
Pigvar	Pighvar	Pigghvarf	Tarbot
Thunfisk	Thunfisk	Tunfisk	Thonyn
			Witvis
Hvitting	Hvidling	Hvitling	Wijting
Mare Flyndre	Skjaerising	Mareflundra	Bot
Stenbid	Stenbide	Vanlig Hafkatt	Zeewolf

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ALGERIA

Adragna, Gaëtan, à Bou Haroun.
Aime Robert, 3, rue Berlioz, Alger.
Ampart Fréres, à Chiffalo.
Ampart Yves, Bou Haroun.
Apiccla & Salsano, 25, rue Camille-Douls à Alger.
Berma Ets, 1 rue de Lyon à Alger.
Cacciuttolo Augustin, à Tenes.
Comptoir Algerien des Produits d'Ouetre-Mer, 7 rue Denfert-Rocheieau, Alger.
Conserveries Algero - Marocaines, à Tenes.
Cooperative Sardinerie, Bou Haroun.
Crescenzo, Vincent, 2, bis rue du Liban, à Alger.
Decanis & Metivet, à Tenes.
Di Crescenzo Raphaël, 4, rue Warnier, à Alger.
Edwige Dominique, Cité des Viaux Moulins Bt A, à Alger.
Ehrmann, Pierre, Bd. Voltaire, à Castiglione.
Ferrante, Francois, à Castiglione.
Ferrigno Dominique, 1, bis rue Mazagran, à Alger.
Ferrigno, Louis, 36, rue Bal-El-Oued,
Grondin-Simola, Claude, 45, Av. Raymond Poincaré, Buyotville.
Helal, Abdelkader, 2 rampe Charles Lutaud, à Cherchell
Ideales Conserves (Ets), Castiglione
Liguori, Alphonse, 2 rue Colonel Combes, à Alger.
Macaluso, Sauveur, à Chiffalo.
Mercurio Dominique (Ets), à Chiffalo.
Mercurio, Francois, 1 Rue Mazagran, à Alger.
Mercurio, Joseph (fils de Dominiqueà), à Chiffalo.
Mercurio, Sauveur, à Castiglione.
Pappalardo, Blaise, à Bou Haroun.
Salvo, Paul, à Tenes.
Sarthon (Ets), à Castiglione.
Saturnino, Janvier, 8 Bd. Amiral Pierre, à Alger.
STE FALCONE (PIERRE AINE) & FILS, Chiffalo.
Sté Le Trident, à Bou Haroun.
Striano, Pascal, à Bou Haroun.
Aleman (P.) & Terres (F.), 48, rue Joseph Oliva, à Oran.
Ambrosino, Louis, à Beni-Saf.
Ansar (Sté), Route de l'Abattoir, à Nemours.
Ansar (Sté), (Michel Dateu Fils), à Beni Saf.
Benichou, Roger, Rue Puygreffier, Cité Magnan, à Oran.
Blondelle, Marcel, à Mers-El-Kebir.
Boronad, Jacques, à Beni Saf.
Bouhana Fréres, à Nemours.
Conserveries Jean Bord, 2 rue Lt Sylvestre, à Oran.
Ferrer, L. & B. Bord (Ets), à Nemours.
Ferrer & Payret (Sté), à Nemours.
Fouche, Alex (Mme Vve), Beni Saf.
Galano, Francois, à Nemours.
Galano, Salvatore, et fréres, à Nemours.
Garcia, Emile, 13 rue de Bitche Oran.
Carcia-Carrion, Juan, Rue Eiffel, Villa Such, Montplaisant, à Oran.
Gimenéz, Domingo, 22 rue Charles Quint, Oran
Groupement des Saleurs, à Nemours.
Juan, José Giner, 43, av. Aristide Briand, à Oran
Lacombe & Bader Fréres (Ets), Route du Phare, à Nemours.
Les Saleurs Reunis, à Nemours.
Molines, Pére & fils, à Nemours.
Papparlado, Vincent, & francois, Pointe Ouest, à Nemours
Penalva, Carmen (Mme), 3 rue des Eparges, à Oran.
Pitzini, Vincent (Ets), Lieu dit Pointe Ouest, Nemours.
Reassis, Ets, 4 bd. de l'industrie, à Oran.
Savona, Antoine Ets, à Beni Saf
Sté Algerienne de Salaisons, á Beni Saf.
Sté Falcone, Pierre, Ainé èt fils, Boite Postale 28, Nemours.
Sté Oranaise de Peche & de Conserves, 20 rue Charles.
Tabaries, Henry, 43, bis rue d'Alsace Lorraine, à Oran.
Urquijo & Segura, 3 rue Vaucluse, à Oran.
Honnorat & Cie, Mers-El-Kebir.
Amodeo, Léonard, 9 rue Furnier, á Philippeville.

Banco (Mme Vve Nicolas), Usine de la Marine, à Bougie.
Biscardi, Antoine, 4, rue du 4 Septembre, à Bone.
Bourgeois (Ets), Route de la Corniche, Philippeville.
Bugeya, René & Cie, 49, Quai de la Marine, à Bougie.
Caciotolo, Julien (Ets), Philippeville.
Caciotolo, Julian (Ets), (M. Beisso Antonin, Djidjelli.
Ciolino & Lentini II, Avenue d'Angleterre, á Constantine.
Esposito, Agnel Antoine, 10 rue Vieille St. Augustin, Bone.
Guyon, Philibert, 1 rue Caraman, á Bone.
Scotto Di Vettimo (Ets), Stora.
Sté Bonoise de Saurissage & de Peche, Terrain Souleyre, á Bone.
Sté Franc-Algerienne de Conserves Alimentaires, 14, rue Bugeaud, á Bone.
Zembaa, Amar & Cie (Ets), 2 rue Montgimont, á Djidjelli.

AUSTRALIA

Australian Fishing Industries Ltd., John Street, Berry's Bay, North Sydney, New South Wales. MD: Mr. R. G. Adams. B: At Eden, N.S.W. Trawler Owners, Fish Canners and Preservers, Shipbuilders and Ship Repairers.
Bell (Arthur) & Myers, Eden, N.S.W.
Forward & Stehn, Carnarvon, W.A. Curers.
Fitzgerald (T.), Marine Terrace, Geraldton, W.A. Curers.
Fowler (Jas.), & Sons, 74, Cecily Street, Leichhardt, Sydney.
Fremantle Fish Supply, Fremantle, W.A.
Gotz (H), 26, Gibbons St., Redfern, Sydney.
Green's Products Ltd., Cocora Bay, Eden S.S.W. Quick-freezers and canners.
Lond (A), 1, Bloomfield Road, Darlinghurst, Sydney.
Marks & Co., Pty., Ltd., Regent Lane, Redfern, Sydney.
Metropolitan Fisheries Ltd., Warwick House, St. George's Terrace, Perth.
Ocean Canning Co., P.O. Box 177, Fremantle.
Red Funnel Trawlers Pty., Ltd., No. 5 Wharf, Woolloomooloo, Sydney. N.S.W. M: E. S. Coles. Trawler owners.

BELGIUM

(a) Fresh Seafish

Cloet (F.), rue de Gand, 9, Ostende
Halewyck et Co. (S. A. Huitrières), rue de l'Esplanade, 1, Ostende.
Océan (S. A.), minque No. 29, Ostende.
Osterwind & Fils, Minque, Ostend. TA: Osterwind. D: Osterwind, Victor. Exporters and Importers of fresh fish.
Osterwind (Charles), minque, Nos. 26-27, Ostende.
Pecheries Nationales Belges, Minque, 26, Ostende. Harengs, sardines, saumon congelé, spratts, etc.
Pede (Auguste), Minque, 36 et 57, Ostende.
Rau (René), quai au Bois à Brûler, 45, Bruxelles.
Van den Bemden frères (S. A.), rue Kronenburg, 32-36, Anvers.
Van Graefschepe (Henri,) minque, No. 24, Ostende.
Vermeersch & Cie, Quai aux Briques, 18, Bruxelles.
Vermeersch (A.) & Cie, rive Est du Port, Ostende.
Willems (Camille), minque, No. 21--22, Ostende. Sardines et harengs frais.

(b) Smoked and Dried Seafish

Boels-Derudder (J), Zandvoordestraat, 21, Oostende.
Carbonez (S. A. Sardinerie Henri), Nieuport.
Carbonez-Declercq (A.), rue de la Poste, 7, Roulers.
Debra, Vischmijnstraat, Zeebrugge.
Pede (Auguste), minque, 36 et 57, Ostende.
Rau (E.), et Fils, rue de l'Est, 71-73, Ostende. Harengs, sardines, saumons.
Vanden Bemden Frères (S.A. Establissements), rue Kronenburg, 32, Anvers. Harengs saurs, saumons, etc.
Verbeke-Rau (Jos.), rue du Persil, 86, Bruges.
"Saurisserie La Couronne" S.A., 21, Rue de Zandvooede, Ostende. Exporters and Curers and Fish Canners and Preservers.

(c) Shrimps

Cloet (F), rue de Gand, 9, Ostende.
De Rycker Gebroeders, Vrijheidstraat, 19, Blankenberge.
Pede (Auguste), Minque, 36 et 57, Ostende.

Sardijnenfabriek der Kust (G. Soete), Vaartdijk, 3, Breedene-Oostende.
Vermeersch et Co., rive Est due Port, Ostende.
Vermeersch & Cie, quai aux Briques, 18, Bruxelles.
Vigoria (S. A.), avenue de la Cote, Zeebrugge. Crevettes séchees pour allmentation des animaux.

(d) **Lobsters**

Halewyck et Co. (S. A. Huitrières), rue de l'Esplanade, Ostende.
Pede (Auguste), Minque, 36 et 57, Ostende.
Rau (René), quai au Bois à Brûler, 45, Bruxelles.
Van Graefschepe (Henri), minque, No. 24, Ostende.
Vermeersch & Cie, quai aux Briques, 18, Bruxelles.
Vermeersch (A.), & Cie, rive Est du Port, Ostende.

(e) **Oysters**

Carbonez-Declercq (A), rue de la Poste, 5, Roulers.
Halewyck et Co. (S. A. Huitrières), rue de l'Esplanade, 1, Ostende.
Rau (René), quai au Bois à Brûler, 45, Bruxelles.
Van Graefschepe (Henri), minque, No. 24, Ostende.
Vermeersch & Cie., quai aux Briques, 18, Bruxelles.
Vermeersch (A.), & Cie, rive Est du Port, Ostende.

BRAZIL

Exporters of Dried Fish

Fábrica de Doces e Conservas Gaivotas Ltda., Rua Gama e Melo, 72, Joao Pessoa, Paraíba.
Ferreira & Cia., Caixa Postal 157, Manaus, Amazonas.
Leal, Santos & Cia., Caixa Postal 44, Rio Grande, R.G. do Sul.
Gomes, Barbosa & Cia, Ltda., Caixa Postal 340, Belém, Pará.
Soura, Vieira & Cia., Rua do Mercado 23/25, Rio de Janeiro.

BULGARIA

Kooperazia na konservoproisvoditelite, 2 Al. Stamboliiski, Sofia.
Manol Alekov, 95, Pirot St., Sofia.
Dimitar (Arnaudov), Burgass.
Gorski Coop Saius, Burgass.
Keremedchiev & Vodenicharov, Burgass.
Kazarovi (A. & T.), 49, Blvd. Botev, Sofia.
Kazarovi Brothers, Burgass.
"Kobarelovi" Ltd., Burgass.
Liakovi Brothers, 11 Tri Ushi Št., Sofia.
Kusma Nikolov, 4, Belchev St., Sofia.
Georgi Petkov, 49, Parchevich St., Sofia.
Vladimir Spirov, 45, Blvd. Botev, Sofia.
Atanas Tomov, 6, Blvd. G. Dimitrov, Sofia.
Danail Racv, 25, Solun St., Sofia.
Niko Shterev, Plovdiv.
"Volga" G. Palushev, 153, Rakovski St., Sofia.

CANADA

(a) **Exporters**

Adams & Knickle, Limited, Lunenburg, Nova Scotia. D: H. W. Adams (Pres.), Douglas F. Adams (Vice-Pres.), Everett A. Knickle (Sec.-Treas.).
Bluewater Fisheries Ltd., Saint John, N.B. D: F. C. Schofield, F. B. Schofield, J. E. Frost, S. B. Schofield. A: All world points.
Canadian Fishing Co., Ltd., Vancouver, B.C.
Canadian Fish & Cold Storage Co., Prince Rupert, B.C.
Floyd Frankland & Sons, Church Point, N.S.
Gupthill (Scott D.), Grand Harbour, Grand Manan, New Brunswick. Exporters and Curers: Bloaters, boneless herring fillets.
Jamieson (R. E.), Ltd., Canso, N.S.
Leonard Bros. Ltd., North Sydney, N.S.
Logie (A. R.) Co. Ltd., Logieville, N.B.
Lunenburg Sea Products Ltd., Lunenburg, N.S.
Maritime-National Fish Ltd., Halifax, N.S.
McCormack & Zatman,, Ltd., St. John's, N.B.
McQueen, White & Dickinson Co. Ltd., 1030, Hamilton St., Vancouver, B.C. D: C. McQueen, J. White and S. Dickinson.
Niskersons (H. B.), & Sons, Ltd., North Sydney N.S.
Pecheurs Unis de Quebec, 6381, St. Lawrence Blvd., Montreal.
Preiswerck Ltd., 343, Railway Street, Vancouver, B.C.
Ritcey Bros. Fisheries, Ltd., River Port, N.S.
Seafood Products Ltd., Vancouver, B.C.
Seaport Crown Fish Co., Ltd., Vancouver, B.C.

Shelburne Fisheries Ltd., Shelburne, N.S.

SNOW FISHERIES LTD., representing Associated Foods Ltd., Hubbards, N.S., 711, Royal Bank Bldg, Montreal, Que D: B. K. Snow, A. B. Snow, Mrs. M. J. Snow, W. R. Snow, E. G. Aust. A: Associated Foods Ltd., Hubbards, N.S. (See advert.).

STANDARD FISH COMPANY, 5181, St. Lawrence Blvd., Montreal. D: Wm. B. Cohen, Harry Cohen, David Segal. (See advert.).

Swim Bros., Ltd., Lockeport, N.S.

Szenkovits (Gustav Caspar), Board of Trade Bldg., Montreal. P: C. Szenkovits. B: Reford Bldg., 217 Bay Street, Toronto, and at New York.

Todd (J. H.), & Sons, Ltd., Victoria, B.C.

(b) Trawler Owners

Atlantic Trawlers, Limited, Halifax, N.S.

Cape Agulhas Company, Limited, Halifax, N.S.

Crouse Fisheries, Limited, Lunenburg.

Demone Trading Company, Limited, Lunenburg, N.S.

Golden Ray Fishing Company, Limited, Montreal, P.Q.

Halifax Fisheries, Limited, Halifax.

Lunenburg Sea Products, Limited, Lunenburg, N.S.

Moriarity (W. B.), Company, Limited, Halifax, N.S.

Prospect Trawlers, Limited, Halifax.

Smith (A. M.) & Company, Limited, Halifax, N.S.

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CEYLON

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CHILE

Copania Pesquera "Arauco," San Antonio.

Bonefont y Cia. Ltda., Isla Rocuant, Talacahuano.

San Miguel y Sanz, Colon No. 3050, Talacahuano.

Zaval y Cia., Talacahuano.

Sanz Gonzalez y Cia., Las Salinas, Talacahuano.

Frederico Ringes, San Vicente, Talcahuano.

Francisco Gaus, San Vicente, Talcahuano.

DENMARK

Agnar (Paul), Esbjerg. TA: Agnar. T: 2611/2811.

Andersen (C.), Ny Havn, Esbjerg. T: 2386.

Bandholm Fiskeeksport, Bandholm. TA: "Fiskesalg." T: 61.

Baun - Hanstholm, Hanstholm pr. Thisted. T: Hanstholm 14.

Boye (Laurits), Ny Havn, Esbjerg. T: 220.

Bredkjaer (J.), Ny Havn, Esbjerg. T: 2071.

Christensen (Aage), Ny Havn, Esbjerg.

Christiansen (Charles), Ny Havn, Esbjerg.

Christensen (Ejvind), Esbjerg. TA: Kvalitet. T: 1911.

Christensen (Emil), Esbjerg. TA: "Emil." T: 2623.

Christiansen (Harry), Ny Havn, Esbjerg. T: 1614.

Christiansen (Hartvig), Esbjerg. T: 2308.

"Codan" Fiskefiletfabriken, Rodvig. TA: "Fiskesalg." T: 58.

"Dana Sild," Frederikshavn. TA: Danasild. T: 112.

Dansk Krone Sild, Skagen.

Dyekjaer & Christensen, Ringkobin. TA: Dyekjaer. T: 7/407.

Eriksen (C. Mogensen) Fiskefiletfabrik, Thisted. T: 886.

Esbjerg, Denmark. D: F. V. Hartz, N. Joker and P. Rontved.

Eriksen (Chr.), Ronne, (Bornholm).

ESPERSEN (A.), A/S, Ronne, Bornholm. T: 968. Fish Exporters, Filleters, Curers. (See advert.).

Esphavn's Fiskeeksport, Hals. TA: Esphavn. T: 55.

Faergemann (A. Nielsen), Ny Havn, Esbjerg. TA: Faergemann. T: 2186.

Fiskernes Salgsforening, Nexo. TA: Salgsforeningen. T: 199 and 213.

Glyngore Fiskeindustri, Glyngore. TA: Industrifisk. T: 34.

Hansen (Charles), Dansk Stjerne-Sild, Sct. Paulsgade 4, Aarhus. TA: Stjernesild. T: 12104.

Hansen (Chr.), & Co., Kerteminde. T: 555.

Hansen (C. Grube), Fiskerogeri, Skelskor. T: 350.

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Hansen (Milo), Klintholm Havn Pr. Borre. T: Busemarke 2412.
Hansen (N. A.), Ny Havn, Esbjerg. TA: Hansa. T. 1622.
Harboe (Kr.), Ny Havn, Esbjerg. T: 2435.
Hausgaard (Otto), Hirtshals.
Havnso Fiskerogeri og Fiskeexport, Havnso pr. Folleslev. T: Havnso 15. TA: Dandanell, Folleslev.
Hirtshals Fiskeeksport, Hirtshals. TA: Fiskeespersen. T 25, 75 og 105.
Hjermitsiev (J. P.), Hirtshals. T: 16 and 17.
Host & Co., Esbjerg. TA: Host. T: 2607.
Iversen (Martinus), Esbjerg. TA: Martinus. T: 1619.
Jensen (Tarben P.) I/S, (Niels H. Andersen), Ny Havn, Esbjerg. MD: Niels H. Andersen.
Jensen (Hans), Ronne, Bornholm. T: 1054/279.
Jensen (Jan Kongsdal). T: 2904.
Jensen (Jens Aksel), Ny Havn, Esbjerg. T: 2003.
Jensen (Johannes), Thyboron. T: Thyboron 35.
Jensen (Troger), Ny Havn, Esbjerg. T: 384
Jergensen (Alfred), Esbjerg. TA: Goodfish. T: 1553.
Jergensens (C.), Fiskeexport, Hasselo pr. Vaeggerlose. T: Fernsprecher Vaeggerlose 10.
Joker (N.), Esbjerg.
Kallehave Fiskeeksport, V/Sv. Larsen, Kallehave: TA: Fiskeeksport. T: 40.
Kalundborg Fiskeexport, Kalundborg V/L Sorensen. TA: Fiskeexport. T: 391.
Kjelgaard (P. Brix), Lokken. TA: Kjelgaard. T: 54.
KJÖLBRO (J. F.), Klakksvik, Faroe Islands. (See advert.).
Klenke (Fr.) & Son, Vordingborg. TA: Klenke. T: 372.
Kolle (Jens), Esbjerg. TA: Vesterhavsfisk. T: 1286.
Kruse (L), Kalundborg. T: Kalundborg 893.
Lango Fiskeeksport, Lango pr. Kappel. T: Lango 4.
Larsen (I. A.) & Co., Frederikshavn. M: Larsen (Jens A.). Branches at Elsinore.
Larsen (Anker), Klintholm Havn, pr. Borre. T: Busemarke 2406.
Lauritzen (Johs.), Ny Havn, Esbjerg. TA: Johnse. T: 683/1683.
Lillebaelt Filetfabriken, Skjaerbaek, pr. Taulow. P: Soren Damkjaer. TA: Lillebaelt, Kolding. T: Skaerbaek V/ Kolding 31.
Lohals Salgsforening, Lohals. TA: Salgsforeningen. T: Lohals 46.
Madsen (C. O.), Nr. Vorupor pr. Sjorring. TA: Fiskercompagniet. T: Norre Vorupor 19.
Madsen (M. H.), Esbjerg.
Martens (Carl), Karrebaeksminde.
Mauritzen (Charles) & Co., Thorshavn, Faroe Islands. D: R. P. Brockie (Managing).
Mehlsen (N. C.), Struer. TA: Mehlsen. T: 2.
Mortensen (Hans), Ny Havn, Esbjerg. T: 1179.
Mulberg (Chr.), Ny Havn, Esbjerg. TA: Mulberg. T: 1416.
Naestved Fiskerogeri & Fiskeexport v/ Th. Thomsen, Naestved. T: 478.
Nakskov Rogeri og Fiskeeksport, v/ A. J. Aerebo, Nakskov. TA: Trianglen. T: 856.
Nielsens Fiskeexport og Rogeri Kalundborg. T: 636.
Nielsen (Arnold), Ny Havn, Esbjerg T: 3094.
Nielsen (G.) & Co., Nykobing F. T 841, ved Broen 938.
Nielsen (Lauritz), Skagen.
Nielsen (N. C.), Ved Stranden 16 Copenhagen. T: Central 6563. TA Salmonexport.
Nordkysk Sild- & Makrel-Eksport Frederikshavn. TA: Jalco. T: 364.
Nordso Fiskeeksport, v/ Sigurd Espersen, Esbjerg.
Olesen & Muff, Esbjerg. T: 1847.
Ovesens (J. AA.), Eftf. v/ J. Berg Nielsen, Skagen. TA: Bergfish. T 180.
Pedersen's (Chr.) Fiskeexport, Hals
Pedersen (Hans), Ny Havn, Esbjerg.
Pedersen (Sv. V.), Ny Havn, Esbjerg T: 2899.
Pedersen (V. E.), Ny Havn, Esbjerg TA: Verom. T: 3104.
Petersen (J. J.), Ny Havn, Esbjerg TA: Fiskepetersen. T: 340/398.
Petersen (J. P.) & Kristensen, Faaborg. T: 480.
Petersen (Th.) & Co., Kolding. TA Fiskpeter. T: 748.
Petersens (S. P.), Eftf., Fuglefjord.
Poulsen (Chr.), Hansted pr. Thisted T: Hanstholm 2.
Pryds (Axel), Nykobing F. TA: Pryd T: 278

Reinert (Vilh.), Ny Havn, Esbjerg. TA: Reinert. T: 2844.

RONN (A/S LAUR.), Fishexport, Esbjerg. T: 974 and 2350. TA: Aurora. MD: Mr. George Ronn. A: Thyboron, Hvide Sande, Skagen, Frederikshavn, Aarus and Grenaa. Exporters of Fresh Fish. (See advert.).

Royh (R.) (R. R. Howlett), Ny Havn., Esbjerg. T: 1538. TA: Royhkuller. P: R. R. Howlett.

Samsing (H.), Ny Havn, Esbjerg.

Sauers (J.), Eftf. v/ M. Sauer, Struer. TA: Sauer. T: 16.

Sejrbo & Jensen, Copenhagen. Gl. Strand 44. TA: Haifisk. D: Aage Sejrbo, Christian Krogh Jensen.

Siim (Svend), Ny Havn, Esbjerg. TA: Siim. T: 2680.

Skagerak Fiskeexport, v/ Sigurd Espersen, Hirtshals. TA: Sigurd. T: 125.

Sorensen (Frede), Ny Havn, Esbjerg. T: 2010.

Sorensen, Ringkobing. TA: Fiskeandel.

Steen (H)., Ny Havn, Esbjerg.

Storstrommen, Rogeriet, v/ H. Clausen, Kallehave. TA: Storstrommen. T: 116.

Stubbekobing Fisheexport, Stubbekobing. T: 1049/1339.

Taabbel (P.), Skagen. TA: Taabel. T: 456.

Thimsen's (H.), Fiskeeksport, Esbjerg. TA: Thimsens Fiskeexport. T: 36.

Thietjes Fiskerogeri, Farifagsvej 65, Naestved. TA: Thietje. T:, Fernsprecher 69/1739.

Thomsen-Skagen (I. P.), Skagen. A: Frederikshavn; Hirtshals; Thyboron.

Thuesen (Soren), Ny Havn, Esbjerg. T: 1880.

Thygesen (Chr.), & Co., Kerteminde. TA: Fiskesalg. T: 238.

Vesterhavet, Esbjerg, v/ N. Olesen. T: Esbjerg 1291.

Wedege, Fiskeeksporten, v/ H. V. Samsing. Ny Havn, Esbjerg. T: 1236.

Wilhelmsen (A.), Frederikshavn. and at Hirtshals, Thyboron. TA: Wilhelmsen. T: 4, 43, 350, 340.

Wilhelmsen (Edmund), Frederikshavn. TA: Edmundwilhelmsen, Frederikshavn. T: Frederikshavn 4.

Wilhelmsen (Oscar), Esbjerg. TA: Fiskewilhelmsen. T: 292.

EIRE

Cahill & Young Ltd., Paramount House, 34, Lower Abbey Street, Dublin. D: G. V. Young, S. C. Young, D. C. Young, H. C. Cahill. Depot: Holles Place, Dublin.

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Devane, Patrick, Green Street, Dingle, Co. Kerry. D: Patrick Devane.

Doherty, (James J.), Kincasslagh, Co. Donegal. Represented at Burtonport, Bunby and Maghergallen, Derrybeg.

East Coast Inshore Fishing Co. Ltd., Fish Market, Dublin. D: F. J. McLoughlin, Esq., Mrs. J. M. McLoughlin.

Fastnet Fisheries Ltd., Bantry, Co. Cork.

GALLAGHER BROS., Main St., Killybegs, Co. Donegal. D: Phil Gallagher, Jack Gallagher. Branches: Teelin and Killybegs. (See advert.).

Hurly (Martin), Ardmore, Youghal, Co. Cork.

Irish Sea Fisheries Association, Ltd., 45, Kildare Street, Dublin.

Lucey & Sons, Waterville, Co. Kerry.

Murphy (Jeremiah), Strand Street, Dingle. Pr: Jeremiah Murphy. Lobsters a speciality.

Ogilvie (Brian), Killorglin, Co. Kerry. Pr.: Brian Ogilvie. Agents in Eire only. Shellfish Exporter.

Ohagan & Sons, Ltd., Fish Market, Dublin.

Templecrone Co-Op. Society, Rutland Island, Burtonport, Co. Donegal.

FINLAND

Exporters of:—

(a) **Herring, Salted**

Backlund & Co., Aktiebolag, Vasa.

Helsingfors Konserv Ab., Helsingfors.

Oy. M. Ingo Ab., Vasa.

Kontio & Kontio Oy., Turku.

Lapin Jäätyttamö Oy. — Lapplands Fryseri Ab., Tornio.

Suoman Kalastus Oy, Helsinki.

Tuottajain Lihakeskuskunta r.l. Helsinki.

Alands Andelsslakteri m.b.t., Mariehamn.

(b) **Fresh and Salted**

Oy. M. Ingo Ab., Vasa.

Kontio & Kontio Oy., Turku.

Lapin Jäaytämö Oy. — Lapplands Fryseri Ab., Tornio

Timi J. Smirnoff, Vasa.

Suomen Kalastus Oy., Helsinki.

(c) Salted Cod

Alands Andelsslakteri m.b.t., Mariehamn.

(d) Salmon Fresh and Salted

Oy. M. Ingo Ab., Vasa.

Karjakunta r.l., Helsinki.

Osuuskunta Karjapohjola r.l., Oulu.

Kontio & Kontio Oy., Turku.

Lapin Jaayttamo Oy. — Lapplands Fryseri Ab., Tornio.

Suoman Kalastus Oy, Helsinki.

Kontio & Kontio Oy., Turku.

Lapin Jaädyttamö Oy. — Lapplands Fryseri Ab., Tornio.

Suomen Kalastus Oy., Helsinki.

Alands Andelsslakteri m.b.t., Mariehamn.

FRANCE

Baubain (René), 25, rue d'Orleans, Boulogne-sur-Mer (P.-de-Calais).

Burette (Veuve), 13, rue de l'Amiral Bruix, Boulogne-sur-Mer.

Boubbel & Lecaille, 27-29, rue Montebello, Boulogne-sur-Mer.

Gambier Lehoucq & Co., 15 rue Pasteur, Boulogne-sur-Mer.

Poibieb (Lucien), 7, rue Lebeau, Boulogne-sur-Mer.

Vidob-Sabbaz & Co., 12, Rue d'Orleans, Boulogne-sur-Mer.

GREAT BRITAIN

Alfred Steam Fishing Co., Ltd., Grimsby. Trawler Owners.

Allen & Partridge (Trawlers) Ltd., 2, Norfolk St., Strand, W.C.2.

Alsey Steam Fishing Co Ltd., Grimsby. Trawler Owners.

ANGLO STEAM FISHING CO. LTD., Grimsby. Trawler Owners. (See advert. Rinovia S F. Co.).

Allan & Dey Ltd., Raik Road, Aberdeen. D: John Craig, Mrs. I. Anderson.

AMOS (J), & SON, Herring Buildings, North End, Fish Market, Fish Docks, Grimsby. D: J. J. Amos, W. H. Amos, J. Amos, Senr. Agents: Aberdeen, Newhaven, Oban, Ayr. (See advert.).

ARDROSSAN TRAWLING COY., LTD., Middle Pier, Granton, Edinburgh 5. T: Edinburgh 83528. TA: Brill. Managers: Walter K. Paton, Ltd., 50, Clyde Street, Glasgow, C.1. Trawler Owners. (See Advert.).

Arklie (Fred G.), South Esplanade West, Aberdeen. T: 1042. TA: "Arklie," Aberdeen. Fresh Fish Merchant and Curer.

ASSOCIATED HERRING MERCHANTS LTD., 32, Schoolhill, Aberdeen. D: W. G. Adams, B. Diamantstein, Geo. Donaldson, C. R. Leiding, C. F. Mayo, C. A. McLachlan and Max Saunders. Branches: Lerwick, Wick, Fraserburgh, Peterhead, Stornoway, Castlebay, Gt. Yarmouth and Lowestoft. (See advert.).

Atlas Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

BAGSHAW (R. H.), Wyre Docks, Fleetwood. T: 311. TA: Bream. (See advert.).

Baker (H. C.), & Sons, Ltd., Grimsby, Trawler Owners.

Bannister (A), (Trawlers) Ltd., Grimsby. T: 2246. TA: Saxon, Grimsby. Trawler Owners.

Barber (A. H.) & Co. (Grimsby) Ltd., Riby Street, Grimsby, Lincs.

Bennett (J), (Billingsgate) Limited, Neptune House, Water Lane, London, E.C.3. D: W. A. Bennett, A. K. Ferrier, A. Thorpe.

Bennett Selling Co., Limited, Royal Docks, Grimsby. D: Mr. W. A. Bennett, Miss M. L. Court.

BLOOMFIELD'S LTD., Great Yarmouth. T: 2291. TA: Ocean. Fishing Vessel Owners. Exporters of fresh and cured Herrings. (See advert.).

Bennett (J.) (Aberdeen) Limited, 159, North Esplanade, East, Aberdeen. D: Mr. W. A. Bennett, Mr. G. McGregor, C.A.

Bennett (J.) (Hull) Limited, Billingsgate, Hull. D: Mr. W. A. Bennett, Mr. G. McGregor, C.A.

Bennett (J.) (Wholesale) Limited, Neptune House, Water Lane, London, E.C.3. D: W. A. Bennett. S Cole, F.C.A., H. Wernham.

BOSTON DEEP SEA FISHING & ICE CO LTD., Fleetwood D: F. Parkes, B. A. Parkes, F. Williams, C. L. Wilbraham and H. Palmer. B: At Hull, Grimsby, Aberdeen, Lowestoft, and Great Yarmouth. (See advert.)

Birch Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

Burton (William J.) Ltd., Admiralty Road, Gt. Yarmouth. D: William J. Burton. Agents in all countries of the Mediterranean. Refrigeration for Smoked Herring.

Butcher (E), Fish Merchant, Old Ford Road, Aberdeen. A: Peterhead and Lowestoft.

Byron Thompson, Albion St., Grimsby.

Charleson-Smith Trawler Limited, South Side, St. Andrews Dock, Hull. MD: C. P. Hudson, C. H. Smith.

Coastal Canneries Ltd., 1, Hamilton Road, Lowestoft, Suffolk. D: T. Macpherson, M.P., R. W. Train, C. S. Jenks, N. Gurwitsch. Branch: Ashcroft Road, Kirkby Trading Estate Kirkby, nr. Liverpool. A: Macpherson Train & Co. Ltd., Adelaide House, London Bridge, London, E.C.4.

Capstan Curing Company, Riby Street, Grimsby, Lincs.

Cartmell Trawler Co. Ltd., Grimsby. Trawler Owners.

Cawoods (Fishcurers) Ltd., Eastbourne Street, Hull. D: G. A. Cawood, F. Cawood, H. Cawood, G. Cawood. A: In various countries, Exporters, importers, fish curers and fresh fish merchants.

Channel Trawler Co., Grimsby.

CHAPMAN (ROBERT), LTD., Hutton Road, Fish Docks, Grimsby. T: 5363/4 & 5. TA: Salmon, Grimsby. (See advert.).

Chapman (Sam), & Sons, Fish Docks, Grimsby. P: S. F. and B. Chapman.

Clayburn (J.), & Co. Ltd., Grimsby Docks. T: 2961. TA: Pilot. A: At Lowestoft and Fleetwood.

Consolidated Fisheries Ltd., Grimsby Fish Docks, Grimsby. T: 5426. B: Swansea and Lowestoft. Trawler Owners and Quick Freezers.

Cook (H. Markham), Ltd., Grimsby. T: 5376 (4 lines). TA: "Seafoods," Grimsby. Trawler Owners, Managers, Quick-Freezers, Wholesalers, Importers of Boxed Fish.

Cook (Jim), (Fish Curers) Ltd., Strand St., Grimsby. T: 3968. TA: Strand St., Grimsby.

CO - OPERATIVE WHOLESALE SOCY. LTD., Fish, Game and Poultry Department, 2, Rochdale Road, Manchester, 4. Branches and Agents: Fleetwood, Grimsby, Milford Haven, North Shields, Peel, I.O.M., Esbjerg, Aarhus, Odense, Copenhagen, New York, Montreal, Sydney, etc. (See advert.).

Crampin (The) Steam Fishing Co. Ltd., Grimsby. T: 5144. TA: "Crampin," Grimsby. Trawler Owners.

Curphey (O.), & Son, The Barbican, Plymouth. Managing Owner: E. Whitmarsh. Trawler Owners and Managers, Wholesale Fish Merchants and Salesmen.

Davidson (Jas. M.), Siding Road, Fleetwood, Lancs. P: Gordon N. Davidson, James M. Davidson.

Davidson (Jas. M.) (Fleetwood) Ltd., Siding Road, Fleetwood, Lancs. T: 355. TA: "Goldfish." Fish curer.

Dawson (R. & C. W.), Seahouses, Northumberland. P: R. D. Dawson, C. Dawson, R. P. Dawson, J. R. Dawson. Branches: Glasgow, Mallaig, Newhaven Edin., North Shields.

DERWENT TRAWLERS LTD., Grimsby. Trawler Owners. (See advert Ross Group).

Deveron Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

Diamond Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

Dobson (Charles), Grimsby. T: 2787. Trawler Owner.

Dolphin Steam Fishing Co., Ltd., Grimsby. T: 2222. TA: Arctic. Trawler Owners and Managers.

Dominion Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

Duncan Bros. (Liverpool) Ltd., 2, Rose Street, Liverpool, 1. D: W. A Bennett, Mr. J. G. Duncan.

Eastern Fishing Company (1923) Ltd., St. Andrew's Dock, Hull. D: I. Chapman, Hugh S. Chapman. Trawler Owners.

E.P.E. (Trawling) Co. Ltd., 1, Fore Street, Taunton, Somerset. T: 2294. D: F. H. Edwards, C. W. Edwards, R: H. Penny. Trawler Owners.

Field (Jeff) Ltd., Billingsgate, Hull. T: 37762, 37761, 37160. TA: "Success," Hull. D: G. Field, W. H. Ashby, J. Russell, H. Field, C. Field. Branch: Fleetwood. T: Fleetwood 8252. TA: "Success," Fleetwood. Wholesale Fish Merchants and Curers.

FORBES & FISH, Riby Street, Grimsby. Pr: J. W. Fish. Branches: Sheffield, Bradford, Leeds, Huddersfield. (See advert.).

Forward Steam Fishing Co., Ltd., Grimsby. Trawler Owners.

Franklin (H.) Ltd., Grimsby. T 3754. TA Franklin. Trawler Owner.

FRESH FROZEN FOODS LTD., Irvine, Ayrshire, Scotland. Regd. Office: 3, St. James' Square, London, S.W.1. T. Irvine 2283 D: Sir C. Dennis Barney, Bart., C.M.G., P. G. R. Whalley, C.B.E., J. G. Girdwood, C.B.E., C. P. L. Whishaw. Trawler Owners and Quick Freezers. (See advert.)

Gilby (A. T.) Ltd., Hope Street, Grimsby, Lincs. D: A. T. Gilby, A. T. Gilby, Junr.

Graham (J.) & Sons (Hartlepool) Ltd., D: J. B. Graham, J. B. Graham, Jnr., I. Graham, D. P. Clark. Trawler Owners.

Grant (A.) & Son, Ltd., Grimsby. Trawler Owners.

Gt. Grimsby & East Coast Steam Fishing Co., Ltd., Auckland Road, Fish Docks, Grimsby. T: 5423 (2 lines). TA: "Butt," Grimsby. D. Albert W. Butt, G. W. Butt, Arthur W. Butt, J. W. Butt, W. W. W. Butt, F. Goodwin. Trawler Owners.

Green (Alec), 74, Eastbourne Street, Hull. Pr Alec Green. B: At Doncaster and Billingsgate, Hull. Exporters and Curers.

GRIMSBY INDUSTRIES TRAWLER MANAGERS LTD., Grimsby. T: 5262 TA: Industries. (See advert. of Ross Group).

Grimsby Line & Trawler Co. Ltd. Trawler Owners.

Grimsby Merchants Amalgamated Trawler Co. Ltd., Grimsby. T: 2846. TA: Matro.

GRIMSBY MOTOR TRAWLERS LTD., Grimsby. Trawler Owners. (See advert. Ross Group).

Hawes & Company (London) Ltd., Imperial House, Dominion Street, London E.C.2. A: Throughout the world. Importers of Processed and Canned Fish.

Harrol Trawling Co. Ltd., Grimsby. Trawler Owners.

Hewson (Robert), 256/258, King Edward St., Grimsby, Lines. Curers.

HUMBER TRAWLERS LTD., Grimsby. Trawler Owners. (See advert. Rinovia S.F. Co.).

Humberstone Trawlers Ltd., Grimsby. Trawler Owners.

Japan Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

Kelvin Trawlers Ltd., 308, Clyde St., Glasgow, C.1. D: M. C. Macfarlane, M. B. Macfarlane. Trawler Owners.

KELSALL (JOHN) & SONS, LTD., 108, High Street, Manchester. D: H. K. Latham, J. Pratt. Branches and Agents: Fraserburgh, Gt. Yarmouth, Manchester, Liverpool, Grimsby, North Shields. (See advert.).

Kingston Steam Trawling Co., Ltd. St. Andrew's Dock, Hull.

KOPANES STEAM FISHING CO. LTD. Trawler Owners. (See advert. Rinovia S.F. Co.).

Le Couteur Bros., Rocquaine, Guernsey, Channel Islands. Exporters

Letten Bros., Grimsby. T. 5306 Trawler Managers.

Lindern (Trawler Managers) Ltd., Grimsby. T: 2809. TA: Matador. Trawler Owners and Managers.

Lindsey Steam Fishing Co. Ltd., Grimsby. T: 2222. TA: Arctic. Trawler Owners.

LONDONS (GRIMSBY) LTD., Grimsby. Trawler Owners. (See advert. Ross Group).

Lord Line Ltd., St. Andrew's Dock, Hull.

Loyal Steam Fishing Co. Ltd., Auckland Road, Fish Docks, Grimsby. TA: "Butt," Grimsby. D: Albert W. Butt, G. W. Butt, Arthur W. Butt, W. W. W. Butt, J. W. Butt.

McBurney & Co., Annalong, Co. Down, N. Ireland.

Marr (J.), & Sons, Ltd., Wyre Dock, Fleetwood.

McEVOY (ALFRED D.) LTD., Stanley Road, Peel, Isle of Man. Exporters and curers, Manx kippers. (See advert.).

Medina Fish Co., Ltd., Albion Street, Grimsby. T: Grimsby 3053. TA: Medina, Phone, Grimsby. D. Mrs. E. Baxter, Mr. A. E. Kemp.

Miller (F. A.) Ltd., 27 and 28, Dock St., Leith, Edinburgh 6. T: 36345. TA: "Bacalao." D: F. A. Miller, I. K. Miller, V. A. Densem. Salted Fish Importers and Exporters.

MITCHELL, KERR & RITCHIE, Grimsby. Trawler Owners. (See advert. of the Ross Group).

MOORE (T.) & SONS, 23, Michael St., Peel, I.o.M. TA: Messrs. T. Moore & Sons. D: Mr. P. J. Moore and Mr. F. C. Moore. (See advert.).

More (James) Ltd., Miller Street, Wick. T. 14. TA: More. A: Gt. Yarmouth, Lerwick. Curers.

Moss (T. C. & F.), Ltd, Grimsby. T: [illegible]. TA: Vulcan. Trawler Owners and Managers.

Neale & West Ltd., Wharf St., Cardiff.

Northern Trawlers Ltd., Grimsby. Trawler Owners.

Onward Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

Osborne (A. & R.) Ltd., Grimsby. T: 5013. Trawler Managers.

Ogano Steam Fishing Co., Ltd.; Derron Steam Fishing Co. Ltd.; Tagalle Steam Fishing Co. Ltd., all of Auckland Road, Fish Docks, Grimsby. T: Grimsby 5421.

Orrell Bros., 20, Market Street, Peel, I.o.M. D: H. L. Phillips, D. H. Phillips.

Parker (Joseph), Wyre Dock, Fleetwood, Lancs. P: Joseph Parker, George Edward Dishman. Branch: J. Parker, Fish Docks, Grimsby. Wholesale Fish Merchants and Exporters.

PARKHOLME TRAWLERS LTD., Fleetwood, Lancs. Trawler Owners. (See advert. of the Ross Group).

Perihelion Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

PATON (WALTER K.), Ltd., 50, Clyde Street, Glasgow, C.1. D: W. K. Paton, A. F. Nicoll. B: Granton Harbour, Edinburgh 5. Trawler Managers and Fish Salesmen. (See advert.).

Petrie (Chas.) & Son, Ltd., Rose Street, Liverpool 1. D: Mr. W. A. Bennett, Mr. G. McGregor, C.A.

Pickering (J. W.) Fisheries Ltd., 2, Trawl Market, Lowestoft. D: S. K. Pickering, L. M. Simons. Branch: Fleetwood.

Pettrzopoulos (A.), 30, Block 3, Fish-Wharf, Great Yarmouth. Pr.: A. [illegible]

POMMER & THOMPSON, LTD., South Denes Road, Great Yarmouth. T: [illegible]. TA: Pommer. B: At Aberdeen. Curers and Exporters. (See advert.).

Queens Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

Reed (F. W.), Grimsby. Trawler Owner.

RINOVIA STEAM FISHING CO. LTD., Grimsby. T: [illegible]. TA: Rino. D: J. K. Cabley, J. R. Little, T. B. Little, Mrs. F. Smith. Trawler Owners and Managers. (See advert.).

Robertson (Joseph), Commercial Quay, Aberdeen. T: 1340. TA: Witches. Pr: James Robertson. Wholesale fish merchant and exporter.

Robinson (Harry), Grimsby. T: 3870. TA: Harry Robinson Pantoon. Trawler Owner and Manager.

ROBINSON (J. W.) (FISH) LTD., Wyre Dock, Fleetwood, Lancs. T: 400. TA: "Wings." Exporters and Curers. (See advert.).

Robinson (Sir Thomas) & Son, Ltd., Grimsby. T: 5215. TA: Reliance. Trawler Owners and Managers.

Rodgers (Geo.) & Son, Ltd., Mill Road, Peel, Isle of Man. D: George Rodgers, Catherine Rodgers.

ROSALIND FISHING CO. LTD., Wyre Dock, Fleetwood. T: 502. (See advert.).

ROSS (THOMAS) LTD., Fish Docks, Grimsby. T: Grimsby 5107. TA: Seasparkle, Grimsby. Branches: Aberdeen, Fleetwood and Hull. Fishing Vessel Owners and Managers. (See advert.).

Ross (F. & T.) Ltd., West Dock Avenue, Hull. D: P. Ross, F. C. Ross, R. P. Ross, F. A. Ross, T. Ross. Steam Trawler Owners, Ship Chandlers.

RUSHCLIFFE TRAWLERS LTD., Grimsby. Trawler Owners. (See advert. Ross Group).

St. Annes Trawler Co. Ltd., Grimsby. Trawler Owners.

St. Christopher Steam Fishing Co., Grimsby. Trawler Owners.

Scania Fishing Co. Ltd., 26, South St., St. Mary's Gate, Grimsby.

Scottish Fish Curers Limited, 2, Commercial Street, Leith. D: C. R. Mauritzen (Managing), H. H. Mauritzen, D. M. Hannah.

Shire Trawlers Ltd., Grimsby. Trawler Owners.

Sinclair (James), Fish Curer, Miller Street, Wick. T: Wick 210. TA: James Sinclair Fisheries, Wick. Suppliers of Kippers, fresh Herrings and White fish.

Sleight (Trustees Sir G. F.), Grimsby. Trawler Owners and Managers, etc.

SMETHURSTS (H.) (FISH CURERS) Ltd., Ropery Street, Grimsby. T: 5291. TA: Smethursts. D: Mr. J. F. Morrissey, Miss M. C. Swallow. Quick Freezers; also Importers. (See advert.).

Smith (A. & M.) Ltd., Strickland Street, Hull. D: J. I. Wight, L. A. Smith, R. Holmes, T. D. Smith. Branches: Hull and Aberdeen.

Smith (Fred), Albion Street, Grimsby, Lincs. Fish Curer.

SMITH & RITCHIE (FISHERIES) LTD., 98, Clyde Street, and Fishmarket, Glasgow, C.1. D: A. Ritchie, A. Campbell, M. R. Kennedy. (See advert.).

Standard Steam Fishing Co., Ltd., Auckland Road, Fish Docks, Grimsby. T: 5423 (2 lines). TA: "Butt." D: Arthur W. Butt, W. W. W. Butt, G. W. Butt, J. W. Butt and Albert W. Butt (Man. Dir.). Trawler Owners.

Star Drift Fishing Co. Ltd., Beach Road, Lowestoft.

Stirk Bros., Ltd., 114, Flinton St., Hull. D: G. W. Stirk, E. Stirk, J. Stirk. Branches and Agents: Fleetwood Fraserburgh, Aberdeen, Lowestoft, North Shields.

Sudders (J. C.), (Lowestoft) Ltd., 36, Herring Market, Lowestoft. T: 967. TA: "Sudders," Lowestoft. M: C. E. Trigg. A: Newhaven, Fraserburgh, Hartlepools, Fleetwood, London, and all major Ports. White Fish and Herring Merchants, Fish Curers, Importers Fresh Fish.

SUTTON (HENRY), Great Yarmouth. TA: Enrico. Curers and Exporters. (See advert.).

Sword (Len), Riby Street, Grimsby, Lincs. Pr: Len Sword. Branches: Grimsby, Whitby, Lowestoft, Anstruther.

Tagalie Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

Taylor (H.) Ltd., Murray Street. Grimsby Docks. T: 5104/5. TA: Ostleb. Trawler Managers.

TETHER (GEO.) & SONS, LTD., West Dock Street, Hull. D: J. E. Tether, H. R. K. Tether. (See advert.).

TRAWLERS (GRIMSBY) LTD., Grimsby. (See advert. of the Ross Group).

Ugie Fishing Company Limited, 11, Harbour Street, Peterhead. D: R. Duncan, H. B. Stevenson, R. J. G. Souttby.

United Fresh Herring Exporters Ltd., 3, Herring Market, Lowestoft.

United Steam Fishing Company Ltd., Fish Dock Road, Grimsby. Trawler Owners.

Unity Fishing Co. Ltd., St. Mary Axe, London, E.C.3.

Valentia Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

Vincent (Sid) Ltd., Grimsby. Trawler Owners.

Vynur Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

Wembley Steam Fishing Co. Ltd., Grimsby. Trawler Owners.

W. H. J. Trawlers Ltd., Grimsby. Trawler Owners.

West Dock Steam Fishing Co. Ltd., St. Andrew's Dock, Hull.

WILSON (H.) & SONS, Riby Street, Grimsby. TA: Cedar. T: 3268. Wholesalers and Curers.

Wood (George), 22/24, Shore Street, Portsoy, Banffshire. D: George Wood.

HONG KONG

Exporters

(a) to Singapore and America:

Shing Cheung, 154, Des Voeux Road, West.

Man Yuen Hing, 156, Des Voeux Road, West.

Chue Lee, 137, Des Voeux Road, West.

Chun Cheung, 196, Des Voeux Road, West.

Wing Sung Tsan, 132, Des Voeux Road, West.

Luen Hing Hong, 82, Kitchat Street, Kennedy Town.

(b) to China:

Yat Loong, 122, Des Voeux Road, West.
Nam Shing, 184, Des Voeux Road, West.
Tuck Yuen, 41, Ko Sing Street, 1st floor.
Wing Tai, 100, Des Voeux Road, West.
Wing Lee, 116, Des Voeux Road, West.
Hop Hing, 14, Mui Fong Street.
Mou Lee, 144, Des Voeux Road, West.
Nan Tai, 166, Des Voeux Road, West.
Leung Hing Kee, 7, Mui Fong Street.
Man Yuen Hing, 156, Des Voeux Road, West.
Fook Loong, 160, West Voeux Road, West.
Hon Yiu Kee, 2, Eastern Street.
Tuck Hing, 134, Des Voeux Road, West
Nam Yick, 184, Des Voeux Road, West
Kwong Hing, 126, Des Voeux Road, West.
Ho Cheung Hong, 174, Des Voeux Road West.
Tuck Wah, 7, Mui Fong Street.
Chan Yiu Kee, 10, Eastern Street

Kwong Hop, 10, Mui Fong Street.

Hong Kong Fisheries Co-operative, c/o Fisheries Office, G.P.O. Building, Hong Kong.

ICELAND

Samband Islenzkra Samvinnyfelaga, (Federation of Iceland Co-operative Societies), Reykjavik, Exporters of frozen fish.

THE ICELANDIC FREEZING-PLANTS CORP., Reykjavik. D: Dr. Magnus Z. Sigurosson. (See advert.).

UNION OF ICELANDIC FISH PRODUCERS, Reykjavik. Central sealing organisation for salt fish. (See advert.).

Union of Icelandic Freezing Plant Owners, Reykjavik. Exporters of frozen fish.

INDIA

Burjor Ardeshir & Co., 254, Bunder Road, Karachi.

Hooseinbhoy Shallooani & Co., P.O. Box 266, Karachi.

I. S. & Co., Machado, 18, Beach Road, Tuticorin, S. India.

The Kaivarthaka Industrial Works, Mangalore S.K. (S. India. D: B. Mohanappa Thingalaya. A: Throughout India and Ceylon.

Swamikannoo Pillay (A.), Maruthi Vilas, Alleppey.

Pahrdhandas Mangoomal, Old Market, Kharadhar, Karachi.

P N.P. Jainulabdeen & Bros., 39, Govindappa Naick Street, G.T. Madras.

West Coast Fisheries (Travancore) Ltd., Main Road, Trivandrum, Travancore. Curing, canning, cold storage and fish-by-products.

ITALY

MARIO PONTECORBOLI DI GIACOMO, Via A. Gramsci 3-8, Genova, II (Office). Canning Factory at Chioggia (Venezia). Branch at Trieste—Riva Grumola 6. (See advert.).

MEXICO

Cia. Pesquera de Sonora, S.A., Apdo. 242, Nogales, Son.

Coop. de Pescadores "Bahia de los Angeles," Apdo. 212, Mexicali, Bfa.

Cooperativa Pesquera, S.C.L., Apdo. 35, Salina. Oz. Oax.

NETHERLANDS

Admiraal, Secr. Varkevisserstr. 1581, Katwijk aan Zee. P: J. C. Admiraal, Jh. Admiraal, C. Admiraal.

Admiraal (Thomas) C.V., Hoofdstraat 58, Noordwijk aan Zee. TA: "Fatoma." P: H. Admiraal, J. Admiraal.

BRUSSAARD'S HANDELMAATSCHAPPY N.V., Vredenoordkade 15, Rotterdam. D: Brussaard, J. H., Brussaard, A. L. (See advert.)

Co-operative Union of Ysselake Fishermen, Ysselake. Control 600 fishing boats. Export Representative: J. G. Lindenberg, Scheidam—q.v.

Dorman's Export Rookerij, Treilerweg 32, Scheveningen. T: 557927. Curers.

Dooseman (Walter W.), Kromme Waal 36, Amsterdam. Exporters.

N.V. Katwijksche Reederij & Haringhandel v/h A. den Dulk, van der Vegtstraat 44, Katwijk aan Zee. Trawler Owners, Exporters and Curers.

DULK (B. DEN), Zuidstraat 99, Katwijk aan Zee. Exporters and Curers, also Importers. (See advert.).

Gelderen (N. van), Haven 46-47, Maassluis. Exporters of Herrings.

Globe Fish Packing Factory, P.O. Box 31, Vlaardingen (Zomerstraat 51). D: G. v. Teylingen.

Goedknegt (Peter), 118, Schiedamscheweg, Vlaardingen.

Kegge's Vishandel, Grote Visserijstraat 6d, Rotterdam. Pr: A. A. Kegge. Exporters and Importers of fish and fish preserves. Stock fish agents.

Kwakkelstein (W.). Westhavenkade 65-69, Vlaardingen. P: D. Kwakkelstein, M. J. Kwakkelstein. Exporters and Curers, Cold Storage.

Lindenberg (J. G.), Boterstr. 19, Schiedam. T: 67370. TA: Preserved. Exporters of fresh fish, salted and smoked herring, etc.

Meerburg's Noordzeevisscherij & Haring Export, C.V., Katwijk a. Zee. E: 1824.

Muys (Jan), Hoekstr. 27, Spakenburg. Curers.

Schaap (A. de) Ltd., Swammerdamstraat 38, Amsterdam. MD: S. Henselijn. Exporter and Importer of canned fish.

N.V. Scheepsexploitatie - Maatschappij "De Marezaten," Trawlerkade 38,

Ymuiden. P: J. Polderman. Trawler Owner.

Taat Bros, Katwijk aan Zee Trawler Owners, Ship Repairers.

Van der Toorn, Treilerweg 74, Scheveningen T: 551338. Export, Curers and Canners.

Vijver (Henri van der) & Co., Westersingel No. 35, Rotterdam. MD: D. Vooys. A: All over the world.

Van der Windt's Handel Mij, Parallelweg 4. Vlaardingen. MD: G. v. d. Windt.

Viss Mij. Vlaardeningen, Vlaardingen. Trawler Owners.

Visschery Mij "Piscator," Schiedamsche weg 91, Vlaardingen. D: W. Brouwer Azn. Trawler Owners.

Vrolik (Frank), N.V. v.h., Scheveningen. Shipowners, exporters, curers, cold storage.

Visser (Koen) N.V., **Oostkade 14**, Oud-Bejerland. D: K. Visser, G. Visser, S. Visser. Fish Curers.

WIJNBELT & CO., P.O.B.2, Woudrichem. (See advert.).

WINGERDEN (H. VAN) & ZOON, Scheveningen. T: 553383. TA: Wingerden. MD: H. J. van Wingerden (Chairman Association of Herring & Fish Importers, Holland). (See advert.).

Zeevischgroothandel Job Gouda, Ijmuiden. D: Job Gouda, D. J. Gouda.

Zwan & Zn. (A. v. d.), Scheveningen, Trawler Owners.

NEWFOUNDLAND

Licensed Exporters of Salt Fish :

Adams (J. F.), Round Harbour.

Ashbourne, Ltd., Twillingate.

Avalon Trading Co. Ltd., Bank of Montreal Bldg., St. John's.

Bowring Bros., Ltd., St. John's.

Baine, Johnston & Co., St. John's.

Baird (James) Ltd., St. John's.

Bartlett (Geo. A.), Burin.

Brown, (H. C.), Tack's Beach.

Buffett (G. & A.), Ltd., Grand Bank.

Blackmore (Pearce), Pilley's Island.

Bartlett (R. F.), Lascie.

Bowers & Starkes Ltd., Nipper's Harbour.

Battiste (George), Channel.

Crosbie & Co. Ltd., St. John's.

Cape St. Francis Co-op. Soc., Pouch Cove.

Carter, Geo. J.), Ltd., Herring Neck.

Dixon (Geo. T.) Ltd., Fortune.

Dawe (H. B.), Cupids.

Dawe (Geo.) & Sons, Ltd., Port de Grave.

Dawe, (Lewis), Coley's Point.

DIXON (GEORGE T.) LTD., Fortune, Burin District. D: George T. Dixon, John R. Dixon, William Dixon, E. W. Riggs. Exporters and Curers, Vessel Owners. (See advert.).

Dunphy's Ltd., Curling.

Earle Sons & Co. Ltd., Fogo.

Earle Freighting Service Ltd., Carbonear.

East Coast Fisheries, St. John's.

Fishery Products Ltd., St. John's.

F U. Trading Co. Ltd., Port Union.

Grand Bank Fisheries, Grand Bank.

Garland (Thos.) Ltd., Gaultois.

Gillett, John & Sons, Twillingate.

Green (E. J.) & Co. Ltd., Winterton.

Gosse (G. & M.), Spaniards Bay.

Grates Cove Co-op. Soc., Grates Cove.

Harvey & Co. Ltd., St. John's.

Hallett (T.), Ltd., St. John's.

Hopkins (Geo.), Old Perlican.

Harding (A. B.), Norris Point.

Howell (E.) & Bros., Lumsden.

Hiscock (J. W.) & Sons, Brigus.

Job Brothers & Co. Ltd., St. John's.

Lake & Lake, Ltd., Fortune. D: H. B. C. Lake, Harry Lake, H. R. Lake, S. G. Lake. Curers of Salt Fish.

Lake (H. G. Clyde) Ltd., 135, Water Street, St. John's.

Moores (W. & J.) Ltd., Carbonear.

Mifflin, (S. W.) Ltd., Catalina.

Manual (Arthur), Twillingate.

McDonald Sons & Co., Goose Cove.

Marshall (James H.), Reef's Harbour.

Milley (W. B.) & Sons, Pacquet.

Mifflin (S. W.) Limited, Catalina. D: Samuel W. Mifflin (Man. Dir.), Gordon C. Mifflin (Asst. Man. Dir.), Harold I. Mifflin (Sec.-Treas.). Exporters and Curers.

Murray (A. H.) & Co., St. John's.

Norman (H.) & Sons, Pacquet.

Newfoundland Associated Fish Exporters Ltd., St. John's, Newfoundland. T: 969-970-971-803. TA: Nafel. Salt fish exporters.

Nfld. Lab. Exp. Co. Ltd., St. John's.

Noble, (L. J.) & Sons, Nipper's Harbour.

Norris (J. B.) & Co., Coachman's Cove.

Newman Brothers, Petites.
Osmond Brothers, Moreton's Harbour.
Organ (Matthew), Red Bay, Labrador.
Penny (John) & Sons Ltd. Ramea.
Petite (J.) & Sons, English Harbour West.
Pomery & Penny, St. Anthony.
Piercey (S.), Grand Bank.
Parsons (W. G.) & Sons, Ochre Pit Cove.
Ryan (James) Ltd., Bonavista.
Reeves (John) Ltd., Englee.
Roberts, (S. G.), Triton.
Robbins (James Sr.), Lumsden.
Steers Limited, St. John's.
Strong (James) Ltd., Little Bay Islands.
Seaway Co-op. Society Ltd., Change Islands.
Southern Shore Trading Co., Ferryland.
Swyers (J. T.), Co. Ltd., Bonavista. D: J. T. Swyers (Man. Dir.), A. G. Swyers (Sec.), Edmund Swyers, Howard Harris. Exporters all grades Codfish Cod Oil, Dried Squid, Pickled Fish Cod Liver Oil, etc.
Strangemore (E.), St. Anthony.
Tors Cove Trading Co., St. John's.
Tilley (Clarence), Elliston.
Tucker (T.) & Sons, Burnt Point.
Vardy (E.), Hickman's Harbour.
Warr (Geo.) & Son, Pilley's Island.
Wareham (A.) & Sons, Harbour Buffett.
Wareham (W. W.) & Sons, Harbour Buffett.
Wiscombe (J. W.), Marystown.
Woodman, (F.), New Harbour.
Williams (C. G.), Triton.
White (A. T.), Fleur de Lys.

NEW ZEALAND

N.Z. Fisheries Ltd., Wakefield Street, Wellington. Trawler Owners.
Sanford Ltd., Jellicoe St., Auckland. D: A. F. Jagger, F. G. Baskett, F. M. Hills, W. C. Motion, R. S. Thompson, H. Turner. B: 25, Liverpool St., Haymarket, Sydney.

NORWAY

Christiansen (Joachim) A/S., Fjordgt. 62/64, Trondhjem. Manager: Christiansen (Joachim).
A/S Hausvik (Einar) & Co., Vagsalmenning 3, Bergen. D: Hausvik (Carsten). Exporters and Curers, Fish Canners and Preservers.
A/S Mowinckel (Juh. Ludw.) & Son, Bergen.
Mowinckel (Harald) A/S., Bergen. D: Mowinckel (Harald). Mowinckel (Edward).
Robertson (G.) A/S. Hammerfest. Exporters.
Rolfsen (Erik) A/S, Kristiansund N. D: Gunnar Rolfsen, Bj. Rolfsen, Berghild Rolfsen.
Steen-Nilsen (A.) A/S, Tolbodgaten 3, Oslo. D: Steen-Nilsen (A.).
STATENS KJOLEANLEGG OG FRYSERI, Aalesund. **D: Asmund Solbakk. (See advert.).**

PALESTINE

Nakshon, P.O.B. 550, Haifa. Trawler Owners.

PHILIPPINES

Pedro V. Cruz, Concepcion, Malabon Rizal.
Victorio Lachenal, Navotas, Rizal.
Ildefonso Lachenal, Navotas, Rizal.
Mrs. Emilia de Paez, Navotas, Rizal.
Elpidio Javellana, 1153 G. Tuason, Manila.
Marcial Santos, Navotas, Rizal.
Augusto C. Cayco, Navotas, Rizal.
Leoneh & Co., Regina Bldg., Escolta, Manila.
Philippine Fishing Corporation, Malabon, Rizal.

POLAND

" Arka " Tow. dla Polowów morskich, ul. Rybacka 7, Gdynia.
Baltycka Spólka Rybna, Port Rybacki, Gdynia.
CENTRALA RYBNA SP. Z.O.O., Pulawska 20, Warszawa. (See advert.).
"Dalmor" Przedsiebiorstwo Polowów Dalekomorskich, Sp. z.o.o., Rybacka 11, Gdynia.
" Hel " Telska spólka rybacka, Port Rybacki, Gdynia.
" Lawica " Polowy dalekomorskie, Port Rybacki 7, Gdynia.
" Spolem" Zw. Gosp. Sp. R.P., ul Mokotowska 61/11, Warszawa.

PORTUGAL

Empress Comercial de Pesca, S.A.R.L., Lisboa.

SOUTH AFRICA

National Trawling & Fishing Company Limited, West Quay Docks, Cape Town. D: Dr. J. G. van der Horst,

Mr. R. W. Ovenstone, Mr. E. J. G. van der Horst. Branches: Cape Town, Johannesburg. Durban, Port Elizabeth.
Irvin & Johnson Ltd., P.O.B. 1628, Cape Town.

SPAIN

Angel Ojeda (Hijos De), Artilleria 46, Gijon. D: Justo Angel Migel Cipriano Gerardo. Trawler Owners.
Hijo (Ramirez), Calle de Santander, 11 Castro-Urdiales (Santander). Pr: Hijo (Ramirez). Exportation of Anchovies in Salt and in Oil.

TUNISIA

Camilleri Nicholas, 38 Rue d'Espagne, Tunis.
O.T.U.S., Avenue Jules Ferry, Tunis.
Ste Africaine des Produits Conserves, Route de Monastir, Sousse.
Ste Franco Tunisienne des Conserves du Sahel, Route de Monastir, Sousse.
S.A.C.O.T. Ste Anonyme des Conserveries Tunisiennes, Sousse.
Union des Stes Cooperatives de Peche & d'Armement, 6 Rue Amilcar, Tunis.
Sauveur (M. Cros), 6 Rue Dr Rio Bland, Bizerte.

TURKEY

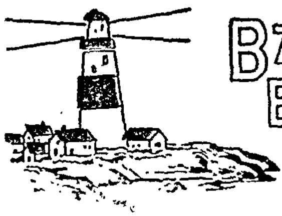
(All firms below are exporters)
Abdülkadir Tömek, Fevzi Pasa Bulvari 64/1, Izmir.
Ahmet ve Celâl Ikizler, Cumhuriyet Bulvari 107, Izmir.
A. Lafont ve Mahdumlari Ltd., S. Sukru Saracoglu Bulvari, Izmir.
A. Mikalef ve Serikleri, Pestemlcilar 1334 Sokak 6, Izmir.
Ibrahim Alagil ve Surekasi Anadolu Baharat Deposu, Yeni Kava Flar 2, Izmir.
A. R. Barki ve Serki, Yemis Carsisi 854 Sokak 52, Izmir.
Ege Ticaret T.A.S., Atkürk Caddesi 24, Izmir.
Hayim I. Levi, Misirlt Han 8, Izmir.
Husnu Bakioglu ve Mahdumlari, Fevzi Cakmak Bulvari 6, Izmir.
Izmir Tutsu, ile Temizlenmis (Fumige) Incir T.A.S., Inonu Caddesi, 25, Izmir.
Kâmil ve Mahmut Tinaz Kadesler Kollektif Sirketi, Halimaga C. 37, Izmir.
Omer Kanafani, Kurtulüs 864, Sokak 22, Izmir.
Polikarp Mikalef ve Seriki, Gazi Bulvari 56, Izmir.
Rahamim J. Franko, Yemis Carsisi 54, Izmir.
Sevket Basev ve Hirstofaros Efstratiu, Yemis Carsisi 47/45, Izmir.
Türk Ticaret Bankasi, Ataturk Caddesi 46, Izmir.
Deniz Toprak Urünleri T.A.S., Tutungumrugu 10, Istanbul.
Ali Tansever, Galata Minerva Hani, Istanbul.
Anaryos Iskidis, Balikpazari Meyhane Sokak 20, Istanbul.
Trak T.A.S., Balikpazari Maksudiye Hani 65, Istanbul.
Umit Türk Ltd., Sirketi, Galata Merkez Hani 15, Istanbul.
Satel Türk Limited Sirketi, Galata Merkez Hani 15, Istanbul.
Istanbul Balik Avcilari Kredi, Eminönü Osmanefendi Hani, Istanbul.
Şathei Türk Limited Sirketi, Galata Merkez Hani 1, Istanbul.
Bastas Balik Sanayii T.A.S., Galata Minerva Hani 1, Istanbul.
Metal T.A.S., Beyoglu Istiklâl Caddesi 322 Yeni Han No. 11, Istanbul.
Altay Ticaret T.A.S., Galata Bozkurt Hani K 3 No. 25, Istanbul.
Yakubal Balikcilik ve Ticaret T.A.S., Balikhane Sokagi Kaneti Hani, Istanbul.
Omser Ticaret T.A.S., Yeni Valde Hani 84, Istanbul.
Tibet Ithalât ve Ihracat T.A.S., Galata, Kardesim Sokak 27, Istanbul.
Müttehit Ermis Emniyet Kartal Konserve Fabrikalari T.A.S., Ayvansaray Demirhisar Sokak 90, Istanbul.
Kozma Nikolof, Balikpazari Maksudiye Hani 47, Istanbul.
Nezir Katiman, Galata Hüdavendigâr Hani 73, Istanbul.
Karadeniz Hopa Ambari Ali Finci, Yag Iskelesi Cardak Caddesi 49, Istanbul.
Mahir Kefelioglu, Galata, Rihtim Caddesi Kefeli Hani, Istanbul.
Galip Alevok, Galata Sermet Hani 2, Istanbul.
Osman Etan, Mahmutpasa, Tarakcilar 62, Istanbul.
Samil Ayhan ve Seriki, Galata, Fermeneciler 34, Istanbul.
Bican Bagcioglu ve Ortaklari, Beyoglu, Yenisehir 59, Istanbul.
Ibrahim ve Süleyman Cehreli, Bahcekapi Atabek Hani 21, Istanbul.

JOE BALESTRIERI & CO.

123 JACKSON STREET
SAN FRANCISCO 11, CALIFORNIA
U.S.A.
Cable Address : " BALCO "

Producers, Packers and Exporters, operating our own Fishing Vessels and Freezing Plants

Branches :
Eureka . Pt. Reyes . Fort Bragg . Pittsburg
Martinez . Cordova, Alaska



BALCO BRAND

FISH FRESH . FROZEN . SMOKED . DRIED
SALTED . CANNED . FILLETS . SHELLFISH
LIVERS
MILD CURED SALMON

BERING SEA CODFISH CO.

123 JACKSON STREET
SAN FRANCISCO 11, CALIFORNIA
U.S.A.
Cable Address : " BALCO "

DRIED CODFISH . ALL TYPES SALT FISH

Mehmet Ismail Dalyanci, Galata, Eski Gumruk Sokak Ceceyan Hani 17, Istanbul.

Hakki Tunaduzu, Tutungumrugu Yagcilar Sokak 23/2, Istanbul.

Marmara Ticaret Evi Osman Günel ve Melih Günel Sirketi, Galata Voyvoda Caddesi Cinar Hani, Istanbul.

Andon Mavridi, Tahmis Camli Han 10, Istanbul.

Ibrahim Idalioglu ve Enver Aziz Göknil Kol. S. K.2, No. 13, Istanbul.

Adil Gencogu, Sirkeci Nemlizade Hani 10, Istanbul.

U.S.A.

Alca Products Company, 154, Nassau Str., N.Y. 7, N.Y. Pr: Jules J. Elson.

American Export & Import Co., 222, National Building, Seattle 4, Washington. Exporters of canned fish.

Atlantic Fish & Oyster Co., Inc., 734/740, West Fulton Street, Chicago 6, Illinois. Exporters of processed and frozen fish. Cold Storage.

Bader (W. J.), 116, John Street, New York 7, N.Y. Exporters of canned and dried salt fish.

BALESTRIERI & Co., 123, Jackson Street, San Francisco, 11, California. D: Joseph Balestrieri (President). Branches and Agents: Eureka, Pittsburg, Point Reyes, Martinez, Fort Bragg and Cordova, Alaska. (See advert.).

BERING SEA CODFISH CO., 123, Jackson Street, San Francisco, 11, Calif. D: Joseph Balestrieri (Pres.). (See advert.).

Booth Fisheries Corporation, 309 W. Jackson Blvd., Chicago 6. Ill. Branches and Agents: Throughout United States and Canada.

Columbia River Salmon Co., Inc., P.O. Box 146, Astoria, Oregon. Exporters of processed, canned and mild cured fish. Cold storage.

Davis Bros. Fisheries Co., Inc., 17, Battery Place, New York 4, N.Y. Exporters of processed and canned fish.

Delano Corporation of America, 111, Wall Street, New York 5, N.Y. Exporters of fresh, cured and processed fish.

Exporters Alliance, Inc., 25, Whitehall Street, New York 4. Exporters of canned fish.

Federated Manufacturers Corporation, 37, Wall Street, New York 5, N.Y. Exporters of fresh, cured and canned fish.

Garcia & Aylstock Co., 154, Nassau Street, New York 7, N.Y. Exporters of salted, dried and cured herrings.

Gentry Inc., Box 2076, Terminal Annex, Los Angeles 54, California. Exporters of fish.

Gilbert & Co., Export Department, 119, West 26th Street, New York 1, N.Y. D: Gilbert Jr. (Andrew), Hamilton (Marc I.).

Gwin, White & Prince, Inc., P.O. Box 1835, Seattle 11, Washington. Exporters of canned, frozen and cured fish.

Indo-Pacific Trade Co., 380, Eddy Street, San Francisco 2, California. Exporters of fish.

Lemberger's, 1436 So. Park Ave., P.O. Box 482, Oshkosh, Wisconsin. Live and preserved fish, turtles — for laboratories and museums.

Little America Finer Frosted Foods Co., 36th and Butler Streets Pittsburgh I, Pa.

MAVAR SHRIMP & OYSTER CO., LTD., P.O. Box 66, Biloxi, Mississippi. D: John Mavar, Sr., Mrs. John Mavar, Sr., John Mavar, Jnr., Sam Mavar, Nick Mavar, Victor Mavar. Exporters and Curers. Fish Canners and Preservers, also Frozen Shrimps or Prawns. (See advert.).

Myers (P. R.) & Co., 400, Madison Avenue, New York 17, N.Y. Exporters of sardines, herrings, sprats, anchovies, etc.

Page (A. C.) & Company, 1331 3rd Avenue Building, Seattle 1, Washington. D: A. C. Page, N. V. Page. Exporters of fresh, cured and canned fish.

Robert, Bennett & McCandless, Inc., 97A, Exchange Street, Portland, Maine. D: Wm. R. Bennett Jr., R. P. Robert, W. A. McCandless, Jr.

Schloetelborg (G. F.) & Co., 411, Mutual Life Building, Seattle 4. TA: Telborg, Seattle. Exporters of frozen, mild-cured, canned salmon and other fish products, including fish meal.

Seabord Fishing Co., 220, Broadway, New York 7, N.Y. Exporters of frozen salmon and halibut and also packed mild-cured salmon and salted fish.

Standard International Corporation, 160, Broadway, New York 7, New York. Exporters of fish items.

Sutherland (David H.) Co., 203, American Building, Seattle 4, Washington. Exporters of canned salmon.

United Nations Export Co. Inc., 40, Exchange Place, New York 5, N.Y. D: Mr. Charles Herman (Pres.), Dorothy Lawler (Treas.), Benjamin Kirshman (Sec.), Mrs. G. Herman (Gen. Man.). A: In Venezuela, Ecuador, Cuba, Puerto R.

Vendsyssel Packing Company Inc., 812 Skinner Building, Seattle 11, Washington. D: Frederic A. Hansen, Kenneth J. Prince. A: Belgium and Denmark. Exporters and curers.

WENDT (IVAR), 701, Central Bldg., Seattle 4, Wn. Pr: Ivar Wendt. A: Throughout U.S.A. (See advert.).

Whiz Fish Products Co., 2000, Alaskan Way, Seattle 1, Washington. Exporters of canned, fresh frozen and salt fish.

II—IMPORTERS AND WHOLESALERS

AUSTRALIA

Buckland (W. M.), Municipal Fish Markets.

Cranwin Fisheries Pty., Ltd., Oyster Bay Road, Oyster Bay.

Fuller (W. E.), (Pty.) Ltd., 390, Little Collins Street. Melbourne, C.1, Victoria. D: W. N. Fuller. A: All countries.

Marks & Co. Pty. Ltd., Regent Lane, Redfern. (See Section I).

Lawrence (E. C.), Rooms 2 and 3 2nd Floor, Baird's Buildings, Perth.

Murrell's, 98, Oxford St.. Darlinghurst.

Pacific Trawlers Pty. Ltd., 1, Union St., Waterloo.

Red Funnel Trawlers Pty. Ltd., No. 5 Wharf, Woolloomooloo. (See Section I).

Rochester (G. J.), Municipal Fish Markets.

Woodward & Co., Pty. Ltd., 229, Sussex St.

Silverton (A.), Metropolitan Markets. West Perth.

BRAZIL

Importers of Codfish:—

Berkout & Cia. Ltda., Avienda Rio Branco 9, Rio de Janeiro.

Birkeland & Cia. Ltda., Rue 1º de Março, 20, Rio de Janeiro.

Cunha Lima & Cia., Rua Mayrink Veiga 26, Rio de Janeiro.

Hollevik (A. J.), Rua Buenos Aires 10, Rio de Janeiro.

BULGARIA

Tomoff (Atanas K.), 6, Blvd. G. Dimitroff, Sofia. Importers of fresh, processed and canned fish.

CANADA

Bluewater Fisheries Ltd., Saint John. N.B.

May (A. S.) & Company, 47, Yonge Street, Toronto 1, Ontario. P: May (A. S.), May (A. J. R.).

May (A. S.) & Co., 47, Yonge Str., Toronto Ca., Almax. Importers and Brokers.

Messrs. McQueen, White & Dickinson, 1030, Hamilton St. Vancouver, B.C.

Preiswerck (K. J.) Ltd., 343, Railway St.. Vancouver, B.C. K. J. Preiswerck (Pres.). Hugo Ray K.C. (Dir.).

STANDARD FISH COMPANY, 5181. St. Lawrence Blvd., Montreal. (See Advert. and Section I).

CEYLON

Cargills Ltd., Fort, Colombo, Ceylon.

Colombo Cold Stores Co. Ltd., Elephant House, Slave Island, Colombo, Ceylon.

Millers Ltd., Fort, Colombo, Ceylon.

New Colombo Ice Co., Colombo, Ceylon.

COLOMBIA

Barbur Hermanos, Plaza del Ecuador. Cartagena.

Carulla y Cía, Carrera 8, No. 11-42, Bogatá.

Casa Belga, Bogotá.

Daunas (Julio), Cra 8, No. 11-56, Bogatá.

José de Bedout & Cía, Calle 11, No. 11-02, Bogotá.

Hijos de Juan Torres, Carrera 13, No. 12-37, Bogotá.

Dávila & Co., Santa Marta (Magdalena).

Puyana & Compania Ltda., Carrera 17, No. 34-83. Bucaramanga.

Cuartas Hermanos, Carrera 4a, No. 11-27. Cali.

Cuartas & Cadavid Ltda., Calle 12, No. 3-10. Cali.

Gomez & Mejia, Ltda., Manizales.

Manuel Londono A., Manizales.

Alirio Parra, Calle 33, No. 16-78, Bucaramanga.

Jorge Martínez S., Calle 33, No. 15-41, Bucaramanga.

Heliodoro Martínez, Palmira.

Chamat (Alfredo), Calle Larga, No. 52, Cartagena.

Balen Groot Hermanos. Carrera 8, No. 12-53, Bogotá.

Puyana (David y Ernest), Bogotá.

Baquero (Jorge Z.), Cra. 8, No. 12-10, Bogotá.

Hermanos (Cuervo) & Cía. Ltda., Calle 13, No. 14-07, Bogotá.

Almacenes Unidos, Carrera 10, No. 9-14, Girardot.
Alvarez (Antonio V.), Calle 35, No. 16-19, Bucaramanka.
Rojas & Steffens, Ltda., Carrera 5a, No. 14-85, Cali.
José Cardona H. & Cía. Ltda., Calle 12, No. 3-44, Cali.
Zuluaga (Daniel), Manizales.
Julio Ocampo G., Manizales.
Pico (Marco A.), Calle 33, No. 15-63, Bucaramanga.
Gómez (Luis Ignacio), Calle 33, No. 15-03, Bucaramanga.
Fernández (José) & Cía., Plaza de Bolivar, Buenaventura.
Alvarez (José Matías), Quibdó (Int. del Chocó).

CYPRUS

Theocharides Ch.M. & Co., P.O. Box 81, Nicosia.
Thras. Tryfon & Bro., Tryfon Buildings, Nicosia.
Zagoreos (D. S.), P.O. Box 129, Nicosia.

EGYPT

Abdou Darwiche, Moharrem & Hassem, Cairo.
Abdou Medina, 105 shareh Saptieh, Cairo.

EIRE

Flanagan (Martin J.), 18, Broad Street, Waterford.
McGettigan (J. J.), Main Street, Killybegs, Co. Donegal.
Hemsworth (C. & M.) Ltd., 12/15, Cornmarket Street, Cork. D: V. O'Sullivan, M. V. Conlon.

FRANCE

Beaurain (Rene), 25, Rue d'Orleans, Boulogne-sur-mer. Importers, Cold Storage.
Poux Moleux & Co., 71, Rue Porte Gayole, Boulogne-sur-mer. D: Poux (Alfred), Moleux (Henri). Importers and Exporters of Fresh Fish.

GREAT BRITAIN

Abbott (Herbert), Fish Docks, Grimsby. T: 5184 (2 lines). TA: Civility. D: Matthew Herbert Abbott, Jack Abbott. B: Wyre Docks, Fleetwood. T: 8192. TA: Civility.
Alexander & Wood Ltd., 46/54, Close, Newcastle-on-Tyne. D: C. Russell Wood, A.C.A., and W. G. Wood. B: North Shields and Sunderland.
A.I. Fish Supplies, Back Midland Bank, Guiseley, nr. Leeds. Pr: F. A. Westmoreland. B: Also at 27 stand, Billingsgate, Hull. Wholesale Fish Merchants.
Appleyard (Walter) & Son, Ltd., 49, New Pontoon, Fish Docks, Grimsby. D: Walter Appleyard, W. Philip Appleyard, H. Appleyard. B: Fleetwood. Wholesale Fish Merchants.
Archbold (C.) & Sons, Seahouses, Northumberland. P: J. C. Archbold, N. Archbold. Fish Merchants.
Bacon (G. A.), 2, Billingsgate Mkt., London, E.C.3. T: Man. 0960. TA: Bacon, Billingsgate. Importers of fresh fish.
Bain & Morrison, Fish Market, Stornoway, Scotland. P: John Morrison. B: Ullapool. Fish Salesmen.
Baxter & Son, Ltd., 16, 223 and 224. Billingsgate, E.C.3. T: Man. 9055. TA: Baxter, Billingsgate, London. D: G. J. Baxter, F. K. Baxter, J. G. Baxter, W. A. T Baxter.
BEE (GEO. B.) LTD., Fish Dock Road, Grimsby. MD: George Bennett Bee (See Advert.).
Bennett (J.), (Billingsgate) Ltd., Neptune House, Water Lane, London, E.C.3. (See Section I).
Bennett (J.) (Wholesale) Ltd., Neptune House, Water Lane, London, E.C.3. (See Section I).
Bennett (J.). (Hull) Ltd., Billingsgate, Hull. (See Section I).
Bennett Selling Co. Ltd., Royal Docks, Grimsby. (See Section 1).
Bennett (J.), (Aberdeen) Ltd., 159, North Esplanade East, Aberdeen. (See Section 1).
Bookless Bros. (Glasgow) Ltd., 149, Bridgegate, Glasgow. D: Bookless (G. T.), Mitchell (Irvine). A: All principal ports.
Broughton & Co. (Fwd.) Ltd., Wyre Dock, Fleetwood, Lancs.
Best (W.), & Sons, Ltd., Fish Docks, Grimsby. T: 2643. TA: Basses, Grimsby. D: W. Best, E. E. Best, O. A. Best.
Blackburn (James), Wholesale Fishmarket, Manchester 4. Pr: Donald J. Belcher.
BLOOMFIELD'S LTD., Great Yarmouth. **T: 2291. TA: Ocean. Fish Salesmen. Fish sold on commission at Yarmouth, Buckie and Fraserburgh.** (See advert.).
Blyth (Horace A.), Wyre Dock, Fleetwood, Lancs. T: 241.

Bowler (T.), & Co. Ltd., Wholesale Fish Market, Manchester 4.

Brekkes Ltd., St. Andrew Dock, Hull. T: Hull 37741-42. TA: Brekkes, Hull.

Brooks & Co., Fish Docks, Grimsby. Sole Pr: S. Bridge. Wholesale Fish Merchants.

Brown Brothers (Leeds) Ltd., Wholesale and Retail Fish Markets, Leeds, 2, Yorks. Also at 125, Westgate, Wakefield, Yorks. T: 26059/24806. TA: "Seasparkle," Leeds. D: G. T. Almond (Man. Dir).

Bruce (Alex.) Jr., 146, Market Street, Aberdeen, Scotland. P: Mrs. J. S. B. Forbes. Wholesale Fish Merchant and Curer.

Bruce (David T.) Ltd., 231, Market Street, Aberdeen. D: P. T. Bruce, M A. Bruce.

Bruce (Jas.), & Co., Newhaven, Edinburgh. T: 83470-83822. TA: Cockles. Pr: Jas. Bruce.

Bruce (Frederick H.), Co. Ltd., Wholesale Fish Market, Birmingham 5. T: Midland 2144. TA: Gull. D: Bruce Normansell.

Campbell (George), 4 to 6, Commerce Street, Lossiemouth, Morayshire. T: 3005. Pr: G. B. Anderson.

Chadwick (Joseph), Wholesale Fish Market, Manchester 4. D: S. A. Chadwick, C. Chadwick, C. Chadwick.

Chapman (Sam), & Sons, Wharncliffe Road, Fish Docks, Grimsby. T: 2747-3028. TA: Crab. D: Samuel Chapman, Fred Chapman and Benjamin Chapman.

Colam (Frank) Ltd., Wholesale Fish Market, Manchester. T: Deansgate 4000. TA: "Capstan." D: Colam (F.), Colam (J.), Colam (E.).

Coleman & Son, Wholesale Fish Market, 2, Queen's Road, Nuneaton. T: 2381/9. TA: Coleman, Fishmonger. Pr: John Briggs Coleman.

Cook (H. Markham) Ltd., Grimsby. Importers of boxed fish. (See also Section I).

CO - OPERATIVE WHOLESALE SOCIETY LTD., 2, **Rochdale Road, Manchester 4. (See advert. and Section I).**

Coulbeck (Sam), Fish Docks, Grimsby. T: 4681.

Crockford (W. A.), Billingsgate, Hull. P: W. A. Crockford, L. A. Crockford, S J. Crockford. B: At Fleetwood, Heckmondwike. Bradford.

Crystal Ice & Cold Storage Co., Canon Street, Canonmills Edinburgh, 3. P: S. K. Simonsen.

Dale (A.), & Son, Wholesale Fish Market, Manchester. D: Albert Dale, Norman S. Dale.

Dawson (E. L.), 63, Fish Dock, Fleetwood, Lancs. T: 330. TA: Dawson, Fish Docks, Fleetwood. P: H. G. and E. L. Dawson.

DISHMAN & DEGNAN LIMITED, St. Andrews Dock, Hull; Fish Docks, Grimsby. T: 38154. D: G. H. Dishman, T. W. Jervis, S. Marchant. A: Rotherham & Burnley. (See advert.).

Douglas (George), Holy Island, Northumberland. T: 215. TA: Douglas, Fishmerchant, Holy Island, Northumberland.

Duncan Bros (Liverpool) Ltd., 2, Rose Street, Liverpool 1. (See Section I).

Duncan (John), Son & Co., (Wholesalers) Ltd., 6/7, Wholesale Fishmarket, Liverpool 1. (See Section I).

Duthie (Arthur) & Co. Ltd., Lossiemouth, Scotland.

Eddie (W. A. A.), 56, Clyde Street, Glasgow, C.1. T: Bell 2761/2. TA: Eddie, Glasgow. D: W. A. A. Eddie, D. E. Eddie, E. B. Eddie. B: At Aberdeen, North Shields and Billingsgate Market, London. Importers of fresh, processed and canned fish.

Elkington (S. W.), Fish Docks, Grimsby. Branch: Boston, Lincs. (Inland Wholesale). Wet Fish Distributor (Coastal).

England (Horace) Ltd., St. Andrew's Dock, Hull. TA: "Merling" Fishbo, Hull. D: H. England, I. H. England.

Fish Food Depot., Wholesale Fish Market, Bell Street, Birmingham, 5. Pr: Mrs. A. Kerby. Inland Wholesalers.

Frisby (E. R.), Fish Docks, Grimsby. T: 4956. TA: "Tip Top." Pr: E. R. Frisby. B: E .R. Frisby (Fleetwood) Ltd., Fleetwood.

Goodhand (F. R.), Fish Docks, Grimsby. T: Stand 4723; Office 55590. TA: "Allfresh." Pr: F. R. Goodhand. Wholesale Fish Merchants.

Grix (W. & A.), Fish Quay, Low Lights, North Shields, Northumberland. T: North Shields 65. TA: "Grix, North Shields." Pr: Raymond Grix.

Hansell (B.), 4, Herring Market, Lowestoft.

Hartley (W.), Fish Docks, Grimsby. B: Fleetwood.

Hawes & Company (London) Ltd., Imperial House, Dominion Street, London, E.C.2.

Hewtson (C. W.) & Son, Wyre Dock, Fleetwood. Pr: Hewtson (C. M.).

Hill (J J.) & Co., 95, 111, 114, 115, Billingsgate Market, London. T: Man 2230/3305. TA: Mynahill, London; Dalfish London. D: J. J. Hill (Snr.), R. D. Daltrey, J. J. Hill (Junr.). A: R. H. Daltrey & Co.

Holmes (R.), & Sons, 32, Bridge Street, Berwick-on-Tweed. B: St. Ives, Cornwall.

Horsburgh (George), 7, Fish Market, North Shields.

Hull Herring Importers Association, Suffolk House, Silver Street, Hull. Secretary: G. W. H. Palmer, F.C.A.

Keay (D. H), Fish Docks Grimsby. T: Grimsby 4753. TA: "Qualfish," Grimsby. P: D. H. Keay, Senr., D. H. Keay, Jun. B: Wyre Dock, Fleetwood. T: Fleetwood 434. TA: "Qualfish," Fleetwood.

Messrs. Law Bros., Ltd., 6, Egbert St., St. James's Market, Bradford, Yorkshire. MD: James Wm. Haley. A: Grimsby, Hull.

LEVINGS (A. W.) & SONS, Wholesale Fish Market, Manchester 4. P: A. W. Levings, S. Levings, H. Levings. (See advert.).

Lauder (George) & Coy. (Aberdeen) Ltd., 1, Clyde Street Aberdeen. D: George A. C. Walker, Andrew Walker, Henry W. P. Walker. B: At Peterhead. Importers and Curers.

Luxton (J.) & Co., 176/171, Billingsgate Market, London, E.C.3. Pr: H. R. Luxton. J. E. Ladyman (London Manager), B: At Fleetwood and Aberdeen.

McBrearty (James), Fish Market, Glasgow, Scotland. Pr: James McBrearty.

Main (A. & J.), Aberdeen, Scotland. T. Aberdeen 204; House 4767. TA: "Progress," Aberdeen. Sole Pr: James E. W. Mann.

Maritime Fish Limited, Wyre Docks, Fleetwood. T: Fleetwood 8372. TA: "Maritime." D: Capt. Harry Blackburn. Alderman Henry Blackburn, Ruth Maguire, Cyril J. Fox, Henry Chippendale.

Mayo (William) & Sons, 96, High Street and 27, Thomas Street, Smithfield Market, Manchester 4. D: William Mayo, Robert Mayo.

Miller (F. A.) Ltd., 27/28, Dock Street, Leith, Edinburgh, 6. (See Section I).

Miller (Thomas A.) & Co., 26, Wholesale Fish Market, Liverpool, 1. P: Thomas A. Miller.

Morton (C. & E.) Limited, Portsoken House, 155/157, Minories, London, E.C.3.

Mumby & Ingham, Fish Docks, Grimsby, Lincs. T: 2097. TA: "Personal, Grimsby." P: Benjamin Ingham, D. Greenwood, F.Comm. A., F.S.C. B: Wyre Dock, Fleetwood, Lancs. TA: "Personal, Fleetwood."

Normansell (Henry), Wholesale Fish Market, Birmingham 5. T: Midland 3312, 0494. TA: Normansell. P: Frederick Henry Normansell, J.P., Frederick Bruce Normansell. B: At North Shields.

Northern Delicacies Ltd., Nordel House, 170, Waterloo Road, Manchester, 8. T: Broughton 2233. TA: Delicacies.

O'Hagan (Owen) & Sons, Wholesale Fish Market, Oxford St., Belfast, N. Ireland. Pr: Emma O'Hagan. B: Owen O'Hagan & Sons, Wholesale Fish Market, Dublin, Eire.

Patterson (J. C.) & Co. Ltd., Newcastle-on-Tyne. MD: W. S. Patterson.

Petrie (Chas.) & Son, Ltd., Rose Street, Liverpool, 1. (See Section I).

Pibel (Stanley) Ltd., 21, Monument Street, London, E.C.3. T: Man. 3210. D: Neil Mackay (Ch), R. O. Lowe, R. T. Clack, W. Jackson Wallace. B: At Aberdeen, Fleetwood, Grimsby, Hull, Lowestoft, North Shields, Milford Haven.

Procter (H. G.) & Son, 72A, Billingsgate Hull. P: H. G. Procter, E. A. Procter.

Ratner (J. C.) & Co. Ltd., 44, Fish St. Hill, London, E.C.3. T: Man. House 2152/2153. TA: Etnarock, Bilgate, London. Pr: L. Moochnik. Importers of canned fish.

Richardson (W.) (Neath) Ltd., Fish Market, Milford Haven. T: 210. TA: Quality. D: W. E. Richardson, H. L. Richardson, W. B. Richardson. B: At Fish Market, Swansea.

Roach Bros., 3, 4, 5 and 10. Central Market, Hull, E. Yorks. T: 36587-35411. TA: "Roach," Hull.

Roberts & Capron Ltd., Riby Street, Grimsby. T: 5093/4. TA: Shrewd. D: H. N. Franklin, S. Kendall. B: Lowestoft, Aalesund.

Robertson (Joseph), Commercial Quay, Aberdeen. Wholesale Fish Merchant and Exporter. (See Section 1).

Robinson (Stanley) & Co., 14, Grants Buildings, Fish Docks, Grimsby. T: 2083. TA: Avail. D: Stanley Robinson, Eric Kemp.

Ross Bros. (Grimsby) Ltd., 19, West Market, Docks, Grimsby. P: T. Ross, C. Ross.

Salomonsen (E. L.) & Co., Ltd., 6 and 7, St. Dunstan's Lane, London. E.C.3. D: J. F. Nielsen (Man. Dir.), C. E. Baylis, L. M. Winstone, E. E. Salomonsen.

SHIPPING AND TRAWLING SUPPLIERS LTD., The Docks, Milford Haven. T: 515. TA: Suplidor. D: D. F. Browne, D. A. Wilkie and Harry J. Richards. B: At Newlyn and Falmouth. (See advert.).

Sidwell & Co. Ltd., 28, Monument St., London, E.C.3. T: Mansion Ho. 0021. TA: Healthiest Samonsales. D: H. Sidwell, H. C. Sidwell, A. E. Norris.

Sleight (Frederick), Fish Docks, Grimsby. T: Grimsby 3338. TA: Acme, Grimsby. Pr: A. V. King.

Smith (Fred), Albion Street, Grimsby. (See Section 1).

SMITH & RITCHIE (FISHERIES) LTD., 98, Clyde Street and Fishmarket, Glasgow, C.1. (See advert. and Section 1).

Spaven (Ben), Wholesale Fish Market, St. Helen's, Lancs. T: 3143. Pr: Ben Spaven. A: Warrington, Widnes.

Stephenson (Ron.), Murray St., Fish Docks, Grimsby, Lincs. T: 3685. TA: Attentive. A: Fraserburgh, Lowestoft, and Yarmouth.

Storr (Fish Merchants) Ltd., Fish Market, Hull. T: 37185. TA: Storr Fishbo, Hull. D: J. W. Storr, J. W. Storr, Junr., A. Poole, S. F. Berriman.

Sudders (J. C.), (Lowestoft) Ltd., 36, Herring Market, Lowestoft. (See Section 1).

Sutton Bros., Limited, Fish Quay, Hartlepool. T: 6162-6163. TA: "Sutton."

Taylor (E. B.) Ltd., Fish Docks, Fleetwood.

TETHER (GEO.) & SONS, LTD., West Dock Street, Hull. (See advert. and Section 1).

WALKER (EDW.) & SONS, Newhaven, Edinburgh. P: Edwin J. Walker. (See advert.).

Walton (W. A.), St. Andrew's Dock, Hull.

Webster (Geo.), Fish Docks, Grimsby. Pr: George Webster.

West (Ernest), North End, Fish Docks, Grimsby. Pr: Ernest West.

Williams (B. H.) & Son, Fish Docks, Milford Haven, S. Wales. D: B. H. Williams, G. B. Williams.

INDIA

Wild Game & Sea Food Co., Sitaram Building, Crawford Market, Bombay.

ITALY

Cardini (Eugenio) & Co., Via della Venezia, 1, Livorno.

Carnice (Giovanni), Mercato del Pesce-Piazza Cavour, Genoa.

Carosini & Parodi, Piazza Filippo Corridoni 10/9, Genoa.

Carpaneto (Angelo) fu Gaetano, Mercato del Pesce, Piazza Cavour, Genoa.

Galletti & Crovetti, Mercato del Pesce, Piazza Cavour, Genoa.

Gambaro (Luigi), Mercato del Pesce, Piazza Cavour, Genoa.

Giolfo & Calcagno, Via della Marina, Genoa.

Gunalachi (Mirone M.), Via Ariosto, 3, Trieste.

Hesse (Alberto), Piazza Nicolo Tomasseo, 1 Trieste.

Itimport, S.A., Via Victor Hugo, 3, Milano.

Ittitalia—Gen. Ital. Commercio Ittico, Via Carlo Alberto, 11, Milano.

La Rocca (Lorenzo), Piazza G. Bovio, 8, Napoli.

PONTECORBOLI (MARIO, DI GIACOMO), Via Gramsci 3/8, Genoa. (See Section I and Advert.).

Mazzola (Iginio), Piazzâ Nuova Borsa 94, Genoa.

O.S.A.I., Via Vecchietti, 6, Firenze.

Sciumach (Angelo), Via G.T. Ivrea 14/4, Genoa.

WAX & VITALE, Darsena, Genoa. (See advert).

NETHERLANDS

(a) **Importers and Wholesalers.**

Boelaars (A. P.), N.V. Agentuur & Commissiehandel, Anth. v. Dijckstraat 7, Amsterdam-Z. D: A. J. Boelaars and W. Boelaars.

BRUSSAARD'S HANDELMAATSCHAPPY N.V., 15, Vrednoordkade, Rotterdam. (See Section I and advert.).

DULK (B. DEN), Zuidstraat 99, Katwijk-aan-Zee. (See advert. and Section I).

GLOBE FISH PACKING FACTORY, P.O. Box 31, Zomerstraat 51, Vlaardingen. (See advert. and Section I).

Leidsche Handelsvereeniging, N.V., Korte Mare 2, Leiden. D: J. de Roo.

Lindenberg (J. G.), Agentuur en Commissiehandel, 19, Boterstraat, Schiedam. Pr: J. G. Lindenberg. A: Neth., Indies, Africa, India, Ceylon, North and South America.

Schaap (A. de) Ltd., 38, Swammerdamstraat, Amsterdam. (See Section I).

WIJNBELT & CO., P.O.B. 2, Woudrichem. Importers of fresh, processed and canned fish. (See advert.).

WINGERDEN (H. VAN), & ZOON, Scheveningen. (See advert. and Section I).

(b) **Importers of Stockfish and Salted Fish.**

Abshoven (P. H. v.), te Vlaardingen.

Fa. Admiraal, te Katwijk-a-Zee.

Baars (J.), te O. Beijerland.

Bolderhey (L.), Binnensingel 64, Vlaardingen.

Bückmann & Pool, te IJmuiden.

Burg (C. v. d.) en Zn., Postbus 36, Vlaardingen.

Don (Jan) en Co., Oosthavenkade 82, Vlaardingen.

Dorp (J. C. v.) en Zonen, Postbus 43, Vlaardingen.

Groen (S. I.), 3e, Havenstraat 1, IJmuiden.

Heul (v. d.) en Valk (v. d.), Westhavenkade 45. Vlaardingen.

Hoek (W.), Niewstraat H. 45, Middelburg.

Hoogerwerf en v. Leeuwen, Westnieuwland 6, Vlaardingen.

Kegge (A. A.), Gr. Visserijstr. 6a, Rotterdam.

Kornaat's (G.), Handel Mij. Kon. Wilhelminakade NZ.6, Vlaardingen.

Kwakkelstein (W.), Westhavenkade 66. Vlaardingen.

Fa. Schouten, Wijk bij Heusden.

Smit (A.), en Zoon, Brouwersgracht 162, Amsterdam.

Smit (A.), en Zn., le Meddellandstr. 94. Rotterdam.

Toor, (v.), N.V. Oosthavenkade 89. Vlaardingen.

Verburg (M.), Zusterstraat 32, Middelburg.

Vlis (A. v. d.), le v. Leiden Gaelstr. 33. Vlaardingen.

WINDT (v. d.) EN CO., te Vlaardingen. (See advert).

NEW ZEALAND

Fuller (W. E.) & Co. Ltd., "Government Life Building," Wellington. C. Importers of Fresh, Processed and Canned Fish. D: W. N. Fuller. A: All countries.

Hobson (F. J.) & Co. Ltd., 52, Oxford Terrace, C.1., Christchurch D: F. J. Hobson (Manager). B: Hobson's Fish Supply, 799, Colombo St., C.1., Christchurch.

PALESTINE

Eastrade Ltd., P.O. Box 2532, Tel-Aviv.

Ellman (H.), 9, Hagesherst.

Winograd (Israel), P.O.B.2009. Tel-Aviv.

SOUTH AFRICA

Coastal Fisheries, Box 769, Port Elizabeth.

Fishfresh (Pty.) Ltd., 46, Darling Street, Cape Town.

Crouse & Levy, 61 de Korte Street, Johannesburg.

Irvin & Johnson Ltd., Box 1628, Cape Town.

Oelofse Fisheries (Pty.) Ltd., Box 503, Port Elizabeth.

Piels Cold Storages Ltd., Box 1391, Johannesburg.

Scott Bros., Box 224, Durban.

S.A. Fisheries & Cold Storage Co., Harbour Estate, Mossel Bay.

SPAIN

Importers of Dried Salted Fish

Trueba y Pardo, S.A., Uribitarte. 7. Bilbao.

Creaves y Arbaiza, Pl. de Uribitarte, 3. Bilbao.

Daurella (José), Rech. 60, Barcelona.

Valls (Federico Heredia), Guillén. 1. Barcelona.

Martínez (Crótido de Simón), Pacifico, 72, Madrid.

Fidel González de Peredo y Cia., S. en C., Cánovas, 41, Cadiz.

Saimaza, S.A., Goyeneta, 11, Sevilla.

Ruiz (Hijo de Tomás), Relatores, 4, Madrid.

Basterra (Hijos de Pedro), Uribitarte, 5, Bilbao.

Ulnarri (Perez) Ltda., Barroeta Aldamar, 2, Bilbao.
Badel (Vda. de Federico), Ribera, 1, Barcelona.
Subirás (Ricardo y José), Rech, 52, Barcelona.
Sagado (Gonzalez y S. L.), Luis Taboada, 25, Vigt.
Garcia y Compania, Juana de Vega, 13, La Coruna.
Diez y Compania, Barroeta Aldamar, 4, Bilbao.

SWITZERLAND

A la Poisonnerie S.A., Rue de la Corraterie 9, Genève.
Association suisse des marchands de poissons, Bd. Georges Favon 22, Genéve.
Bieler Fischhalle, Schmiedegasse 18, Biel (Bern).
Blattner Sohn, Ermatingen (Thurgau).
Christen (E.), Ltd., Heumattstrasse 21-23, Basle. D: P. H. Christen (Pres.), Carl Happ, LL.D., W. E. Hassler, R. Sulger-Vischer, J. Goetz (Manager). A: Monteux, St. Moritz, Soleure, Schaffhouse.
Christener (Gebr.), Biel (Bern).
Diehl (André), Platanenweg 8, Berne.
Th Dutzi, Ankengasse 4, Zurich, 1.
Ecuyer, Rue Voltaire, 26, Genève.
Ernst (Karl), Jaegerweg 8, Berne.
Frigaliment - Import G.m.b.H., St Margarethen (St. G.).
Gefrierhaus Reinhart, A.G., St. Margarethen (St. G.).
Laeubli (Gebr.), Ermatingen (Thurgau).
Les Pêcheries Orientales S.A., Alexanderstrasse 5, Chur. (Graub).
Lugrin & Cie. S.A., Rue du Rhone 46, Genève.
Moser (F.), 61, Rue de la Serre, La Chaux-de-Fonds (Neuch.).
"Oceana," Fischhandels A.G., Marktgasse 5, Basle.
Pasche (Marcel), Faoug (Vaud).
Rissone (Luigi), & Cie., Via Nassa 20, Lugano.
Rageth-Wyss (Jacob), Landquart (Graub.).
Schmid (Max), 167, St. Jakobsstrasse, Basle.
Seiner & Sohn, Kappelplatz 6, Luzern.
Stadel (A.), 50, Gempenstrasse, Basle.
Vesin (Vve. Rose), Halle de Rive 55, Genève.
Zaro (Aldo), Via Cittadella 15, Locarno.
Zaro (Quirico), Via Cittadella, Locarno.

TANGANYIKA

Economical Stores, P.O. Box 301. TA: Econostore, Daressalaam. A: Throughout Tanganyika.
Provision Stores, Ltd., P.O. Box 42, Tanga. D: N. J. Amin, Sheriff Alladina Pattney, Allimohamed Alladina Pattney.

TRANSJORDAN

Marar, P.O. Box 340, Amman. D: Y. Marar, M. Marar. A: Palestine (Jerusalem).

UNITED STATES

American Mercantile Co. Inc., 33, West 42nd Street, New York City, 18.
American Merchants & Mfrs. Agency, 332 East 69 Street, New York, 21, N.Y. P: Peter Doptoglon, Robert Doptoglon.
Atlantic Fish & Oyster Company, 734-740, West Fulton Street, Chicago 6. CA: Atlan-Fish.
Booth Fisheries Corporation, 309, W. Jackson Boulevard, Chicago 6, Illinois. (See Section I).
Burhop (A. E.) Co., 545 N. State St., Chicago 10, Ill.
Burke (W. A.) & Co., 1264, East 6th Street, Los Angeles, California.
Calderon (Victor M.) Co. Inc., 99, Hudson St., New York City, N.Y. D: V. M. Calderon (Chmn.), Jos. E. Levine (Pres.), Jose M. Calderon, George Harburger, I. E. Hankin (Secretary), A. H. Barnhardt. Brokers and Import Agents.
Cathay American Co., 320, Market Street, San Francisco 11, California. Importers of fish delicacies.
Central States Merchant Co., 800, North Clark Street, Chicago 10, Illinois.
Chesebro, Robbins & Graham, Inc., 1, 2, and 3, Fulton Fish Market, New York 7, N.Y. Importers of fresh fish and fishing products.
Collett-Week-Nibecker, Inc., 424, Third Lane, South Francisco, California. Importers of shark and fish livers and manufacturers of vitamin A and D concentrates.
Cuban American Export, 347/349, Seybold Building, Miami 32, Florida. TA: "Cuamexsa."
Dalton-Cooper, Inc., 200 West 34th Street, New York, 1, N.Y. D: J. H. Garr.
Davis & Co., 201, North Wells Street, Chicago. TA: Davco, Chicago.

Fish Distributors Co-operative Association, Inc., 308, West Washington St., Chicago 6, Ill.

Fromm (F. H.) Co., Inc., 100, Warren Street, New York City, 7, N.Y. D: F. H. Fromm (Pres.), F. H. Fromm, Jnr. (Vice-Pres.).

Fulton Smoked Fish Co., 1011 W. Lake St., Chicago 7, Ill.

Genoa Fisheries, Inc., Fish Pier, Boston, Massachusettes.

Giurlani, (A.), & Bro., 537, Front Street, San Francisco 26, California.

Glencourt Importing Company, Division of Salem Commodities, Inc., 233, Broadway, New York 7, N.Y. (In Canada a Division of Macdonalds Consolidated Ltd.). Note: Both in Canada and the U.S. affiliated with Safeway Stores Incorporated).

Greenebaum (M. H.) Inc., 165, Chambers St., New York 7. D: C. H. Greenwald, Henry Greenebaum, Richard M. Greenebaum.

Grossman, (Erwin L.), 947, E. 104 Street, Brooklyn 12, New York.

Haas Bros., 75 West Street, New York 6, N.Y. P: Haas (Joseph), Haas (Leo).

Jarrell & Rea, 1422 Smallman St., Pittsburgh, Pa.

Johnson Trade Inc., Second & Broadway Buildings, 207, N. Broadway, Santa Ana, California. TA: "Jontrad."

Jordan Lobster Co., Inc., 265 West 14th Street, New York City, N.Y.

Knapp Brothers, 116 Blvd. of the Allies, Pittsburgh, Pa.

Krum (S. S.) & Co., 1, Hudson Street, New York City 13, N.Y. P: Samuel S. Krum.

Lanord Co., 509, Fifth Avenue, New York 18, N.Y. TA: Lanordam.

Larson (The A.P.), Co., 29, Broadway, New York 6, N.Y. TA: Appelarson, Newyork.

Leopold (Boto), 233, Broadway, New York 7.

Levins (S. H.), Sons, 116, North Delaware Avenue, Philadelphia 6. TA: "Levinsons."

Lyon Fish Co., Inc., 811, North Fifth Street, Minneapolis 1, Minnesota. D: Franklyn J. Lyon, Van C. Benton.

McMorran, Lloyd H., 420, Market Street, San Francisco, 11, California. TA: "MacMorran."

McClain (Wm. M.) Inc., 231 S. Front St., Philadelphia 6, Pa.

Marine Products Co., 339/349, West First Street, Boston 27, Massachusettes. Importers of fish by-products.

Meletio Seafood Co., 828 N. Sixth St., St. Louis 1, Mo.

Mid Central Fish Co., 1656 Washington St., Kansas City 8, Mo.

Monllor & Boscio, Sucrs., Inc., P.O. Box 4028, San Juan, Puerto Rico. TA: "Monbo."

Montaner (S.), 116, Broad Street, New York 4. P: Montaner (Sebastian), Montaner (Jose). U.S. sales agent on commission basis for foreign shippers.

Robbins, Inc., 362 W. Kinzie St., Chicago 10, Ill.

ROSEN (SAMUEL), 2128, Lexington Avenue, New York 35, N.Y. (See advert).

Rosenthal (Franz), Inc., 44, Whitehall Street, New York 4, N.Y. TA: Frarosen, N.Y.

Di Santo & Co., Board of Trade Bldg., Duluth 2, Minn.

Smith (W. T.) Company, 128 S. Center St., Springfield, Ohio.

SOUTHGATE BROKERAGE CO. INC., 249, Tazewell St., Norfolk, 10, Va. CA: Southoro. D: D. Pender, Jr. **(Pres.), D. M. Thornton (V.-Pres.), J. B. Ashby, A. J. Heath (Sec.), Gaston Pender (Treas.). (See advert.).**

Steitz (E. F.) Company, Inc., 233 E. Detroit Street, Milwaukee, Wisconsin. Import Brokers.

Tillham Corporation (The), 123-133, William Street, New York 7, N.Y. D: J. H. Mather (Pres. and Treas.), Jos. T. Burger (Vice.-Pres.), E. H. Correll (Sec.).

Trans-World Food Co. (The), 2067, Broadway, New York 23, N.Y. D: Mr. Albert B. Stehr, Mr. Fred E. Weiss.

United States Cold Storage Corp., 1114, Wood Street, Dallas, Texas. D: R. T. Mackenzie (Vice-Pres. and Gen. Man), Al Albey (Supt. Processing). B: Kansas City, Mo., Detroit, Michigan, Chicago, Illinois.

Victor Cory Co., 100, Hudson Street, New York 13, N.Y. TA: Coryfoods, New York.

Vita Food Products, Inc., 644-654, Greenwich Street, New York 14 N.Y. D: V. H. Heller (Pres.), M Nierenberg (Vice-Pres.), L. Schnibbe (Treas.), R. G. Heller (Sec.). A: Chicago, Ill.; Chestertown, Maryland.

Walker Fulton Fish Company, Fulton St. & Union Ave., Chicago, Ill.

Wicker Fish & Poultry Company, 3004 Gaston Ave., Dallas 1, Texas.

III FISH CANNERS AND PRESERVERS

ALGERIA

Ampart Freres, a Chiffalo.
Ampart Yves, Bou-Haroun.
Berma Etc., 1 rue de Lyon, a Alger.
Conserveries Algero-Marocaines, a Tenes.
Cooperative Sardinerie, Bou Haroun.
Idealcs Conserves (Ets), Castiglione.
Ste Falcone Pierre Aine & fils, Chiffalo.
FALCONE (SOCIETE) PIERRE AINE ET FILS, Nemours. MD: Nicolas Falcone. (See Advert.).
Fouche Alex (Mme Vve), Beni Faf.
Garcia Emile, 13, rue de Bitche, Oran.
Pitzini Vincent (Ets), Lieu dit Pointe Ouest, a Nemours.
Ste. Falcone Pierre Aine & fils, Boite Postale 28, Nemours.
Bourgeois (Ets), Route de la Corniche, Philleppeville.
Caciotolo Julien (Ets), Phillippeville.
Caciotolo Julien (Ets), (M. Beisso Antonin), Djidjelli.
Scotto di Vettimo (Ets), Stora.
Ste. Franc-Algerienne de Conserves Alimentaires, 14, rue Bugeaud, a Bone.

AUSTRALIA

Australian Fishing Industries, Ltd., John Street, Berry's Bay, North Sidney. New South Wales. (See Section I).
Eden & Twofold Bay Fish Cannery, Eden, N.S.W.
Fish Canneries of Tasmania Pty. Ltd., 54, Brisbane St., Launceston, Tasmania. D: N. C. Gadsden, K. C. Holyman, A. W. Lightfoot. Branches: Margate, Dunalley, Lady Barran, Devonport, Melbourne.
Fuller (W. E.) Pty. Ltd., "Yencken House," 390, Little Collins Street, Melbourne, C.1, Victoria, Australia. (See Section 2).
Geraldton Canneries, Ltd., Geraldton, W.A.
Green Canneries Pty. Ltd., Box 42, P.O., Merrickville, Sydney, N.S.W.
Hunt's Canning Co., 32, Adelaide Terrace, Perth, West Australia. D: D. S. Hunt.
Hunt & Young, Hopetown, W.A.
Narooma Fish Canning Pty., Ltd., Narooma, N.S.W.
Ocean Canning Company, Sydenham Street, South Belmont. Postal Address: Box 177, P.O., Fremantle. P: Vincent Gardiner.
South Coast Co-operative Ship Building, Canning and Development Society, The, Moruya, N.S.W.

BRAZIL

Empreza de Conservas Mulatinha Ltda., Estrada de Minas, 158, S. Joao do Meriti, Rio de Janeiro.
Fabrica de Conservas Peixe Brasil Ltda., Rua da Algeria 209, Rio de Janeiro.
Frigorificos Nacionais Sul Brasileiros Ltda., Caixa Postal 207, Porto Alegre, Rio Grande do Sul.
Rizzo (A.), Irmaos & Cia., Rua Voluntários da Patria 1240, Porto Alegre, R.G. do Sul.

BELGIUM

Agniez Frères (S. A.), boulevard de la Révision, 91, Bruxelles.
Carbonez-Declercq A., rue de la Poste, 5, Roulers.
Carbonez (S. A. Sardinerie Henri), Nieuport. Sardines.
Excelsoir (S. A.), Impasse de l'Esprot, Ostende. Sardines et autres poissons.
Globus (N. V.), Conserverie, Denayerstraat, 22, Denderleeuw. Haringmakreel-engarna alconserven, halfconserven van haring, sprotten in olie.
Lebrun-Van de Velde Ch., quai au Bois-à-Brûler, 33, Bruxelles. Harengs marinés à la daube, rollmops, sardines russes; marque "L.V."
Ostendia (S. A.), avenue Princess Elisabeth, 32-34, Breedene-Ostende.
Rau Eug., Grand Saurisseric Ostendaise, rue de l'Est, 7-73, Ostende. Harengs, rollmops, sardines, sprats.
Sardijnenfabriek der Kust, G. Soete, Vaartdijk, 3, Breedene-Oostende.
"Saurisserie La Gouronne," S.A., 21, Rue de Zandvoorde, Ostende.
Union des Flandres (S. A.), Eegem et Wingene. Sprats à l'huile.
Vanden Abeele A. et Zoon, Coupurerei, 52, 55, Brugge.
Van den Bemden (S. A. Etablissements), rue Kronenburg, 32, Anvers. Poissons fumés, salés et rollmops.

Van Walleghem et Witdoekt, Ostende. sardines á l'huile.

Verbeke-Rau Jos., rue du Persil. 88, Bruges. Rollmops, harengs marinés et fumés, sprats.

BULGARIA

Kooperazia na konservoproisvoditelite, 2 Al. Stamboliiski, Sofia.

CANADA

Chicken Haddies (1); Herring (2); Pilchards (3); Salmon (4); Sardines (5); Mackerel (6); Finnan Haddie (7); Fish Cakes (8); Haddock (9).

Anglo-British Columbia Packing Co., Limited, The, Vancouver, B.C. (2); (4).

Birks-Crawford Limited, Vancouver, B.C. (2); (4).

Blais, Lewis T., Limited, Quebec, Que. (4).

Bluewater Fisheries, Ltd., Saint John, N.B.

British Columbia Packers, Limited, Vancouver, B.C. (3); (4).

Burnham & Morrill Co., Pictou, N.S. (2); (9).

Burns Fisheries, Limited, Halifax, N.S.

Canadian Fishing Co., Limited, The, Vancouver, B.C. (2); (4).

Cap'n John Sea Foods, Limited, Saint John, N.B.

Cassiar Packing Co., Limited, Vancouver, B.C. (4).

Colonial Packers, Limited, Vancouver, B.C. (2); (4).

Connors Brothers, Limited, Black's Harbour, N.B. (2); (5).

Connors, Lewis, & Sons, Limited, West Saint John, N.B. (5).

Crosse & Blackwell Canadian Co., Limited, Trenton, Ont.

Davis (Frank E.), Fisheries, Limited, Freeport, N.S. (1); (7); (8).

Delaney (R.), & Son, Limited, House Harbour, Magdalen Islands, Que. (1); (6).

Doucet, George A., Tignish, P.E.I. (6).

Eastern Packing Co., Souris, P.E.I. (1); (6).

General Seafoods, Limited, Halifax, N.S. (1); (6).

Great West Packing Co., Ltd., Steveston, B.C. (2); (4).

[illegible]kins Bros., Limited, Summerside, [illegible]E.I.

Johnston, Fishing & Packing Co., Limited, New Westminster, B.C. (2); (4).

Magee (Fred), Limited, Port Elgin, N.B. (2); (5); (6); (7); (9).

Maritime Packers (Canada) Limited, Pictou, N.S. (2); (6).

Matthews & Scott Co., Limited, Queensport, N.S. (1); (4).

National Fisheries, Limited, Vancouver, B.C., (2); (3); (4).

National Sea Products Limited, Halifax, N.S.

Nelson Bros. Fisheries, Limited, Vancouver, B.C. (2); (3); (4).

Nootka-Banfield Co., Limited, Vancouver, B.C. (3); (4).

North Shore Packing Company, Limited, North Vancouver, B.C. (2); (4); (5).

Paturel, Emile, Shediac, N.B. (2).

K. J. Preiswerck Ltd., 343, Railway St., Vancouver. (See Section 2).

Queen Charlotte Fisheries, Limited, Vancouver, B.C. (2); (4).

Quoddy Sea Foods, Limited, Black's Harbour, N.B. (2); (5).

Rheaume (H.) & Sons, Ltd., 456, Mount Stephen Ave., Montreal, Quebec. T: Walnut 5118. TA: "Gaspefish." D: John Rhéaume, Gerald Rhéaume, Hervé Rhéaume. A: Gill & Duffus (L'pool) Ltd., Liverpool, Eng.

Robichaud (S.), & Sons, Richibucto, N.B. (1); (6).

Robin, Jones & Whitman, Limited, Halifax, N.S.

Shaw & Ellis, Pocologan, N.B. (1).

Simpson, Roberts & Co., Ltd., Vancouver, B.C. (4).

Smith Canneries, Ltd., Halifax, N.S. (1); (2); (6).

SNOW FISHERIES LTD., 711, Royal Bank Bldg., Montreal, Quebec. **(See Section 1 and advert.).**

STANDARD FISH COMPANY, THE, Montreal, Que. (4); (5). (See advert).

Todd (J. H.), & Sons, Ltd., Victoria, B.C. (2); (4).

Windsor, (J. W.), Co. Limited, Montreal, Que. (3); (4); 5).

CHILE

Sociedad Industrial Pesquera de Tarapacá, S.A. Cavancha, Iquique.

Mateo Zlatar, Coquimbo 238, Antofagasta.

Sociedad Chilena Industrial de Pesca, Antofagasta.
Compañía Industrial Pesquera de Antofagasta, Antofagasta.
Industrie Pesquera S.A. "Guayacán," Santiago - Agustinas No. 972, Coquimbo-Of.
Conserves y Productos Pesque ros Rendic-Wirembo, -Santiago-Casilla No 3781, Talcahuano-Of.
Tullo Bulat "Adria," El Morro, Talcahuano
Meckes Hnos, San Vicente, Talcahuano
Sociedad Chilena Industrial de Pesca, San Vicente, Talcahuano.
Garavilla y San Miguel, San Vicente, Talcahuano
Sociedad Pesquera Qurbosa, Talcahuano
Instituto Bacteriológico de Chile, Talcahuano.
Honorio Foque, Coronel
Compañía Pesquera "Arauco," Talcahuano
Antonio Colucci, San Vicente Talcahuano.
Guillerma Eickhoff "La Austral," Valdivia.
Germán Ditzel "El Condor," Calbuco, Puerto Montt
Mechesner y Cía "Phoenix," Calbuco, Puerto Montt
Andrade Hnos "Punta Blanca," Calbuco, Puerto Montt.
Elena vda de Oelckers "La Vega," Calbuco-Casilla 2, Puerto Montt.
Juan Klener y Cia. "La Sureña," Calbuco, Puerto Montt.
Augusto Schweinntz, Casilla 366, Puerto Montt.
Sucesión Jorge 2 Ditzel, Calbuco-Casilla S/n, Puerto Montt.
Juan Zmirak Ayacara, Chiloe.
Félix Burg "El Golfo," Quellón Chiloe.
Conrado Ditzel, Quellón, Chiloe.

DENMARK

Aalborg Fiske-Industri, Skibsbryggerivej, Aalborg.
Bornholms Konservesfabrik, St. Kongensgade 110, Copenhagen.
Eckhoffs (Arne) Konservesfabrik, Kerteminde. T: 510. TA· Eckhoff.
Frederikshavn Fiskehermetik-Konservesfabrik A/S, Gl. Mont 14, Copenhagen.
Fyens Konservesfabrik, Odense.
Gubbens Konservesfabriker A/S, Hundested. T: 211.
Hansen (Chr.) & Co., Kerteminde. T: 555.
Kjolbro (J. F.), Klakksvik, Faroe Islands.
Moller (H. A.), Vestre Boulevard 4, Copenhagen V.
Nordsoen Fiskekonserves A/S, Skagen. TA: Nordsoen.
Saeby Fiske-Industri, Badehusvej 20, Aalborg.
Scandinavian Canning Co. Ltd., Esbjerg Hermetikfabrik A/S, Esbjerg. TA: Scancan.
Skagen Fiske Hermetik A/S, L. Strandstraede 20, Copenhagen K.
Value A/S, Helgolandsgade 3/5, Havnso pr. Follenslev.

EGYPT

Fabrique Egyptienne de Conserves Alimentaires, "Kaha," 43 shareh Malika Farida, Cairo.
Societé Misr pour les Pêcheries, S.A.E., c/o Misr Bank, 151 shareh Mohamed Farid, Cairo.

EIRE

Armour & Co. Ltd., Frederick Place, Lurgan, Co. Armagh.
Cahill & Young, Ltd., Paramount House, 34, Lower Abbey Street, Dublin. (See Section 1).
Davidsons (Belfast) Ltd., Ardglass, Co. Down.
Gracey Brothers, Hillhall, Lisburn. Co. Antrim.
Newforge Ltd., Belfast.

FINLAND

Helsingfors Konserv A.B., Helsingfors.
Heltek Oy., Helsingfors.
Rajatammi Oy., Helsinki.
Suomen Kalastus Oy, Helsinki.

FRANCE

Amieux Frères, Nantes-Chantenay (Loire Inf.).
Comptoirs de Conserveries "Au Gendarme" 95, Rue du Petit-Château Charenton (Seine).
Conserveries de l'Atlantique, Le Paludec, Quimper (Finistère).
Establissements Philippe & Canaud, Nantes (Loire Inférieure).

GREAT BRITAIN

Coastal Canneries, Ltd., 1, Hamilton Road, Lowestoft, Suffolk. (See Section 1).

CO - OPERATIVE WHOLESALE SOCIETY LTD., Canning and Preserved Food Factory, Waveney Drive, Lowestoft. T: Lowestoft 895-6-7. Head Office: 1, Balloon St., Manchester, 4. (See advert.).

Cornish Canners (Looe) Ltd., Looe, Cornwall.

Crosse & Blackwell, Ltd., Peterhead, Scotland, and London W.1.

Frigidfish Ltd., Royal Dock, Grimsby, Lincs. Fish Canners and Preservers (Quick Chilling).

Gautier (Albert C.), 58a, Daltry Street, Hull. T: 16529. Fish canners and preservers.

Marela Ltd., 153/155A, Commercal St., London, E.1. D: Mr. I. H. Solomons, Mr. A. Solomons and Mr. H. Solomons.

Marshall & Co. (Aberdeen) Ltd. Sinclair Road, Torry, Aberdeen D: W. B. Williamson, Sidney H. Robinson, H. H. Blythe, G. Robb, Mrs. E. Bruce.

Morton (C. & E.) Limited, Portsoken House, 155/157, Minories, London, E.C.3. D: Maj. Gen. J. Buckley, C.B.E., D.S.O., M.C. (Ch), G. C. M. Spry (Managing), G. A. Dunbar, M.C., H. G. Lazell, H. E. Spry, F.C.A. A: All over the world.

Newball & Mason, Mevagissey, Cornwall.

Northern Delicacies, Ltd., Nordel House. 170, Waterloo Road, Manchester, 8. (See Section 1).

North Sea Canners (of Great Britain) Ltd., The Quay, Wivenhoe, Essex. D: L. C. M. Worsp, S. C. Young, Lt.-Col. C. Hardie. A: Macpherson, Train & Co., Ltd.

Tyne Brands Products Ltd., Fish Quay, North Shields.

ICELAND

UNION OF ICELANDIC FISH-PRODUCERS, Reykjavik. (See advert.).

Haraldur Bodvarsson & Co., Akranes.

Nidursuduverksmidjan á Bildudal h.f., Bildudalur.

Kaldbakur h.f., nidursuduverksmidja, Vatneyri Patreksfjordur.

Fiskidjan h.f., Keflavik.

Gardur h.f., nidursuduverksmidja. Sandgerdi.

INDIA

Abdulla Abdulrahiman & Co., Beach Road, Alleppey. S. India.

Anglo-Siam Corporation Ltd., P.O. Box 8, McLeod Road, Karachi.

India Canning Industries Ltd., 21-178 Governor pet, Bezwada, S. India.

The Kaivarthaka Industrial Works Mangalore, S. Kanara.

Mida & Co., 33, Canning Street Calcutta.

ITALY

Ampelea Conservifici S/A, Trieste.

"Arcai" Att. Riun. Comm. li Agric Ind., via Ticino, 7, Roma.

Comp. Gen. It. della Grand Pesca: Genepesca, Scagli d'Azeglio, 9 Livorno.

Carosini & Parodi, p.F. Corridoni, 10/9 Genova.

Azienda Valli Comunali, corso Vitt Eman., 216, Comacchio.

Soc. Gen. delle Cons. Alim. "Cirio, (Napoli), S. Giov. a Teduccio.

"Florio" Tonnare di Favignana e Formica S/A, via Carlo Alberto, 3/5 Genova.

Giovanna Ghislanzoni, Morbegno (Sondrio).

Lorenzo Larocca, Bari.

S/A Conserve Alimentari "La Littoria, via Morone, 8, Milano.

Pontecorboli, Mario, di Giacomo, via Gramsci 3/8, Genoa. (See Section 1)

S/A Prod. Alim. G. Arrigoni & C., via G. Galatti, 24, Trieste.

S/A Angelo Parodi fu Bartolomeo Carlo Alberto, 3/5, Genova.

Tomasso Moro & Figli, via G. F Carpaneto, 8, Genova, Sampierdorena.

Wax & Vitale, via Brigata Liguria Genoa. P: Dr. Enrico Wax, D Guido Vitale. A: All over the world

MEXICO

Cia. Comercial Interamericana, Apdo 155, Mexico, D.F.

Cía. Pesquera y Empacadora del Paci Apdo. 116, Manzanillo, Col.

Coop. de Pescadores "Bahía de lo Angeles," Apdo 212, Mexicali, Bfa.

Indomex, S.A., 5 de Mayo, 20/10 Mexico, D.F.

La Industrial de Ensenada, Apdo. 2 Ensenada. Bfa.

Pesquera del Pacifico, Apdo. 7 Ensenada. Bfa

NETHERLANDS

"COLUMBIA" CONSERVENFABR., Parallelweg 4, Vlaardingen. (See advert.).

Cons. fabr. en Oesterhandel "De Arbeid, v/h Gebr. Van Dort, N.Z. Haven 40 en 46, Bergen op Zoom.

"Delica" Conservenindustrie, Schokkerweg 48, Scheveningen.

De Herder (E.) & Zn., Harderwijk.

Fa, J. D. v. d. Endt-Louwerse, Grintweg 4, Yerseke.

Fa. Everse en Hoebeke, Breeweg 46, Yerseke.

Fa, Frank Pot, Kon. Wilhelminahaven, Z.O. No. 7, Vlaardingen.

Fa. Gebr. v. d. Berg, Vallaat 16, Makkum.

Fa. Gebr. M. en E. Everse, Damstraat 50, Yerseke.

Fa. Gebr. De Haas, Dubbelstr. 17, Bergen.

Fa. De Haas v. Oost, te, B.o. Zoom.

Fa. Gebr. Dil, Hoogstraat 12, Koog a/d Zaan.

Fa. Joost Pot, Oosthavenkade 69, Vlaardingen.

Fa. "Knegies," Viscons. fabr., Beverwijk.

Fa. De Leew-Geluk, Postbus 3, Yerseke.

Fa. Jac. v. d. Plasse, Damstraat 167, Yerseke.

FA. WIJNBELT EN CO., Postbox 2, Woudrichem. (See advert.).

Firma "Flamingo," Postbus 45, Vlaardingen.

GLOBE FISH PACKING FACTORY. P.O. Box 31, Zmoerstraat 15, Vlaardingen. (See Section 1 and advert.).

Landa (P. A.), Bergen op Zoom, Holland, Korte Dubbelstraat 9. T: 75. D. L. Landa. Fish Canners and Preservers, Marinated Mussels.

Ned. Viscons. industrie "Neco," Stationsweg 61, IJmuiden.

N.V. H. Hartog's fabrieken, p/a Museumpark 1, Rotterdam.

N.V. HUNINK (ANTON), Deventer. Box Bergerweg 175. D: A. A. A. Hunink, W. J. Hunink, H. J. Hunink. Meat and Fish Preserves. See advert.).

N.V. Holl. Inmakerij en Viscons. fabriek v/h firma A. A. Smit, Zuiderdiep 66, Groningen.

N. V. G. IJsseldijk & Zonen, te, Twello.

N.V. Vis Im- en Export Mij. "Eureka," p/a Busman's Haring en Zeevisgroothandel, Nieumarkt 8, Amsterdam (C).

N.V. Vishandel v/h Gebr. Schaap, te, Huizen.

Ouwehand's Haring- en Zeevishandel, Tramstraat 63, Katw.a/Zee.

Sarhama Viscons. fabr., Groenesteeg 5, Leiden.

Thoolse Mossel- en Oester-handel B. W. Baay, te, Tholen

C. V. Tieleman en Dros, Middelstegracht, Leiden.

Van der Toorn's Im- en Exporthandel, Treilerweg 74-76, Scheveningen. D: C. Van der Toorn.

Van der Windt's Handel Mij, Postbox 57, Parallelweg 4, Vlaardingen. (See Section 1).

Van Vollenhoven's Fabriek van Comestibles, N.V., . Haringkade 67a, Scheveningen. D: G. van Vollenhoven.

Viscons. fabr. "Hollandia," Arkelsedijk 14, Gorinchem.

Viscons. fabr. v. Zwieten, Industriestr. 28-30, IJmuiden.

Viscons. fabr. Vico, Postbus 42, IJmuiden.

Visser (Koen), Oostkade 17, O. Beijerland.

"Walcon," Conservenfabrieken v/h P. Geist en Zonen, te, Diepenveen.

WIJNBELT & CO., P.O.B.2, Woudrichem. (See advert.).

WYLAX CANNING CO., P.O. Box 2, Woudrichem. D: T. Wijnbelt Sr., W. Wijnbelt. A: Wijnbelt Frères S. à R.L., 12, Rue Pfeffel, Strasbourg. (See advt.).

Zeevis-en Haringhandel "Doggersbank," Driehuizerkerkweg 17, IJmuiden.

Zwanenberg's Fabrieken NV., Gasstraat 5, Oss.

NEWFOUNDLAND

(a) Salmon Packers

Bagg (James) Sr., Cape La Hune, H.B.

Bowers & Starkes, Nippers Hr., N.D.B.

Caines (A. E.), Norris Point, Bonne Bay.

Collins (Edgar), Newport, B.B.

Combdon (R. A.), Jacksons Arm, W.B.

Dredge (C.), Black Duck Cove, St. Barbe Dist.

Goulding (James), Newport, B.B.

Gregory (Peter), Harricott. St. Mary's Bay.

Hancock (Charles). Beaver Cove, N.D.B.
Hiscock (Wm.), Flat Island, B B.
Hodder (Sidney), Horwood, N.D.B.
Honeycott (Charles), Hr. Breton, F.B.
Hynes (Stephen) St Bernards. F B
Milley (W. B.) & Son, Pacquet, White Bay.
Noble (L. J.) & Son, Nippers Hr., N D B.
Northern Trading Co. Ltd., Nippers Hr., N.D.B.
Parrott (J. F.), St. Bernards, F.B.
Reid (J. C.), Neddies Hr., Bonne Bay.
Roberts (Solomon), Change Islands, N D.B.
Samson & Samson, Flat Island, Bonavista Bay. D: Wm. V. Samson, Lloyd D. Samson.
Sullivan (Michael), Brents Cove, W.B.
Taylor (William), Forests Pt., St. Barbe Dist.
Wheaton (Lionel), Fredrickton, N.D.B.

(b) **Lobster Packers**

Andrews (G. H.), Leading Tickles, Notre Dame Bay.
Boone (I.), & Sons, Cottles Cove, Notre Dame Bay.
Boyd (Gordon), Summerford, Notre Dame Bay.
Brinson (John), Arnold's Cove, Placentia Bay.
Butland (Michael), O'Donnells, St. Mary's Bay.
Chippett (Nath), Leading Tickles, Notre Dame Bay.
Colbourne (C J.), Twillingate, Notre Dame Bay.
Collins (Ernest), Rencontre East, Fortune Bay.
Earle (A. J.), Summerford, Notre Dame Bay.
Eveleigh (Solomon), Newstead, Notre Dame Bay.
Feltham (Reg.), Deer Island, Bonavista Bay.
Head (Stanley), Comfort Cove, Notre Dame Bay.
Hicks (Reginald), Loon Bay, Notre Dame Bay.
Hounsell (Robert), Pound Cove, Bonavista Bay.
Hynes (Robert), Bay l'Argent, Fortune Bay.
N.D. Bay Fisheries, Comfort Cove, Notre Dame Bay.
Nolan (Michael), Southern Bay, Bonavista Bay.
Northcott (A.), Lewisporte, Notre Dame Bay.
Maloney (Patrick), Sweet Bay, Bonavista Bay.
Oldford (Augustus), Burnside. Bonavista Bay.
Parsons (Joseph), Newtown, Bonavista Bay.
Penny (Harold), Canning's Cove, Bonavista Bay.
Penny (John) & Sons, Ltd., Ramea, Burgeo District.
Price (Geo.), Brunette Island, Fortune Bay.
Quinton (Chas.), Red Cliffe, Bonavista Bay.
Roberts (Denis), Fortune Harbour, Notre Dame Bay.
Roberts (Samuel) & Co, Wesleyville, Bonavista Bay.
Scott (Allister), Little Bay East, Fortune Bay.
Sheppard (H. R.), Lark Harbour, Bay of Islands.
Walsh (James), Plate Cove West Bonavista Bay.
West (Irving), Aspen Cove, Notre Dame Bay.
White (Victor), Cottle's Cove, Notre Dame Bay.

(c) **Other Fish Varieties**

Connors Brothers, Petries Point, Bay of Islands.
Earle Sons & Co. Ltd. Fogo, Notre Dame Bay.
Maritime Packers (Nfld) Ltd . Curl Harbour. Bay of Islands.
Piercey's Fish Products, Winterton Trinity Bay.

NEW ZEALAND

Stewart Island Canneries Ltd., Invercargill

NORWAY

Aalesund Canning Co., Aalesund.
Atlantic Canning Co., Stavanger
Bergen Packing Co., Os, pr. Bergen.
Bergen Preserving Co., Bergen.
A/S Bergenhus Canning Co., Bergen
Chr. Bjelland & Co , A/S , Stavanger.
Brandtzæg Canning, Abelvaer.
Cape Canning Co . Ltd , Stavanger.
Central Canning Co., Stavanger.
Concord Canning Co , A.S., Bergen.
East Norway Canning Co , A/S Fredriksstad.
A/S Excelsior Canning Co., Stavange
A/S Fonnes Preserving Co., Ltd Bergen.

Hercules Canning Co., Stavanger.
Jeagers Ltd., Stavanger.
Manger Sardine Factory, Bergen.
Mercantile Canning Co., Stavanger.
Neptun Canning Co., Stavanger.
Norrig Hermetikkfabrikker A/S, Stavanger.
North Sea Packing Co., Stavanger.
Oversea Canning Co., Stavanger.
Raakvaag Canning Co., A/S, Trondheim.
Reform Preserving, Stavanger.
Sandnes Preserving Co., Sandnes.
Sardinfabriken Avance A/S, Stavanger.
A/S Sardinfabrikken Ideal, Stavanger.
Soon Hermetikkfabrikk A/S, Son.
Storm & Bull Ltd., Oslo.
A/S Standard Ltd., Stavanger.
Start Canning A/S, Kristiansund, N.
A/S Stavanger Sardine Co., Stavanger.
A/S United Sardine Factories, Bergen.
Standard Canning Co., Stavanger.
Stavanger Canning Co., Stavanger.
Stavanger Packing Co., Stavanger.
A/S Svithun Sardinfabrikk, Stavanger.
Trondhejm Canning & Export Co., Trondheim.
Union Canning Co., Stavanger.
Western Packing Co., Haugesund.

POLAND

"Spolem" Przemyslowe Zaklady Rybne, Gdynia, ul. Sledziowa 2.
W. Sentkowski, wedzarnia ryb i wytwornia konserw rybnych, ul. Kartuska 5, Gdynia.
Panstwowe Zjednoczenie Przemyslu Konserwowego, ul. Sobieskiego 26, Sopot.

PALESTINE

Kretz (B.), Mea Shearim Market, Jerusalem.
Priman, P.O.B. 2004, Tel-Aviv.
Shaldag (Nun), Tnuva, P.O.B. 282, Tel-Aviv.

PORTUGAL

Adriano Ltda., Rua dos Douradores, 129, Lisbon.
Alonso (Antonio), Conservas, Setubal.
Astra Ltda., Travessa dos Remolares, 23, 3°, Lisbon.
Cascais (A.) Ltda., Avenida da Liberadade, 11, res-do-chao, Lisbon.
Companhia de Conservas Pavilhao, Ltda., Setubal.
Conservas Rainha do Sado, Ltda., Calcada de S. Francisco, 23, 2°, Lisbon.
Conservas de S. Pedro, Ltda., Calcada do Sacramento, 14, 1°, Lisbon.
Continental Sociedade de Conservas Ltda., Matosinhos.
Empresa de Conservas Nereida Ltda., Olhao.
Empresa de Estivas Ltda., Olhao e Portimao.
Expresa Exportadora Lusitania, Ltda., Rua da Prata, 8, 1°, Lisbon.
de Figuerido Armando Gomes, Lagos.
Gargalo (Joao C.), Rue de Arco do Bandeira, 79, 1°, Lisbon.
Lacobrigense Alianca Fabril Ltda., Lagos.
Lopes da Cruz & C.a., Ltda., Matozinhos e Setubal.
Lux Industrial, Ltda., Lagos.
Mariz (C.) & Co., Ltda., Setubal.
Nova Sociedade de Conservas Ltda., Portimao.
Periera, Neto & C.a., Sezimbra.
Portugalia Industrial, Ltda., Portimao.
de la Provote, Ernoul, Pere et Fils, Povoa de Varzim.
Santos, Machado & C.a. Ltda., Setubal.
Sociedade de Conservas Atlas, Ltda., Setubal.
Sociedade de Conservas Belomonte, Ltda., Olhao.
Sociedade de Conservas Invicta, Ltda., Rua Augusta 219, 2°, Lisbon.
Sociedade de Conservas Joana d'Arc, Ltd., Matozinhos.
Societe de Conserves de Setubal, Ltda., Setubal.
Sociedade de Conservas a Universal, Ltda., Matozinhos.
Sociedade Peninsular de Importacao e Exportacao Ltd., Portimao.
Viegas & Lopes. Setubal.
Viegas Louro, Ltd., Armacao de Pera.

SOUTH AFRICA

African Fish Canning Co., P.O. Box 1354, Cape Town. Canned Crawfish.
African Inshore Fisheries Development Corporation Ltd., Box 1628, Cape Town.
Angra Lobster Cannery Pty. Ltd., Box 750, Cape Town. Canned Crawfish.
Atlantic Smokeries, Rosedon Road, Lansdowne, C.P. Dried and Salted Fish, Canned Fish, Fish Pastes.
Cape Lobster Canning Co. Ltd., P.O. Box 115, Luderitz, S.W.A.
Lamberts Bay Canning Co., Box 1523, Cape Town.
Hout Bay Canning Co., 24, St. George's Street, Cape Town. Canned Crawfish.

Hickson Canning Co., 8, Adderley Street. Cape Town. Canned Crawfish

Irvin & Johnson, Dock Road, Cape Town.

Luderitz Bay Cannery (Pty) Ltd., P.O. Box 96, Luderitz, S.W.A.

Namaqua Canning Co., Box 586, Cape Town.

North Bay Canning Co., Box 586, Cape Town.

John Ovenstone Ltd., 52, St. George's Street, Cape Town. Canned Crawfish

Saldanha Bay Canning Co., Ltd., 74, Molteno Road, Cape Town. A: R. T. Turnbull & Co. Ltd., Dashwood House, 69, Old Broad St., London, E.C.2.

Stephan Bros. Ltd., 48, Bree Street, Cape Town. Canned Crawfish, Fish Paste.

Walvis Bay Canning Co., Box 1007, Cape Town.

SPAIN

Albo Hijos de Carlos, S.A., Paz, L. Vigo.

Alonso (Antonio) Hijos, Felipe Sanchez, 118, Vigo.

Almadrabero, Consorcio Nacional, Sevilla, 3, Madrid.

Cabo de Penas S.A., Luanco, (Oviedo).

Cantabrica, La, S.A., Fabrica de Conservas Santander.

Cerquera, Antonia J., Calle Canido, Vigo.

Conservas Sacco, S.A., Playa de Coya, Vigo.

Cabrera Hijos, Ltda, P. Sanz, 25, Vigo.

Curbera Jose R, Felipe Sanchez, 118, Vigo

Gandara y Haz, Ltda., Guixar, 6, Vigo.

Garcia (Rogelio), Nueva, 20, San Sebastian. D: Rogelio Garcia

Gomez, Antonio Vazquez, Muelle Portugal, Ayamonte, (Huelva).

Hermanos, Herrero, S.A., Candad. (Oviedo)

Industrial Gallegas S.A., Michelena, 30, Lage, Pontevedra

Jesus, Jose Feria, Muelle Portugal, Ayamonte, (Huelva).

Jesus, Rafael Gomez, Comandante [illegible] Ayamonte, (Huelva).

Lamberti Rodolfo Alonso, S.A., Arrecife de Lanzarote (Las Palmas)

Liman Pedro Borrero, Primo de [illegible] Huelva

Martinez, Rafael Utrera, San Sebastian, 1, Tarifa, (Cadiz).

Masso Hermanos, S.A., Compostela, 14, Vigo.

Maturana, Juan B., Capitan Zubiaurre, 3, Bermeo, (Vizcaya).

Ojeda, Hijos de Angel, Artilleria, 40, Gijon.

Orlando, Salvador, Guetania (Guipazcoa).

Parodi, Juan Bautista, Muelle Rivera, 15, Isla Cristina (Huelva).

Perez, Bernardo Alfageme, Tomas Alonso, 330, Vigo.

Perez y Feu, Joaquin Vega, Ayamonte, (Huelva).

Persquerias Canarias, S.A., Santa Cruz de Tenerife.

Pesquera del Norte de Espana, La, Hospital, 36, La Coruna.

Pesquerias Asutrianas, S.A., Luanco, (Oviedo).

Rey de Briz, Apartado, 24, Vigo.

Ribas (J.), e Hijos, Tomas Alonso, 330, Vigo.

Sanfilippe, Baltasar Scola, Rivadesella, (Oviedo).

Serrats, Jose, Capitan Zubiaurre, 26, Bermeo, (Vizcaya).

Sociedad Conservas Peran, Candad Oviedo.

Sucs. de Domingo Vilas Martinez, Sta. Eugenia de Riviera (Coruna).

Vaello, Bartolome Galiana, Queiop de Llano 8, Tarifa (Cadiz).

SPANISH MOROCCO

Almadraberas Africanas, S.A., Larache.

Cantabro Mediterranea S.A., P.O. Box 203, Tetuan. Gen. Manager: Jose Marsal Renouf. Factories at Melilla and Algeciras

Consorcio Almadrabero, S.A., Larache.

Luigi Dassori, Alonso Gurrea, 5, Melilla.

Angel Herrero, Pescaderia de S. Lorenzo, Melilla.

Ramon Iborro Such, Pescaderia de S. Lorenzo, Melilla.

Vitorique Merino (Demofilo), Montemar, 27, Melilla.

Rafael Ginel, Pareja, 12, Melilla.

Jose y Lion de Carranza, Fabrica de Conservas, Larache.

Julio Azuara Martin, Agujero 5, Ceuta

Comp Agricola de Lukus, S.A. Fabrica de Conservas, Larache.

José Marques, Fabrica de Conservas, Arcila.

Ramón de Carranza Gomez, Playa de Rivera, Ceuta.

Pedro Castillo Borrego, Sardina, 23, Ceuta.

Sucs de Delgado y Maeso, J. A. Primo Rivera, 24, Ceuta.

Manuel Escudero Espinosa, B. Sardina, Ceuta.

Benito Lamorena Moreno, Almadraba, 62, Ceuta.

Antonio Llada Blanco, B. Sardina, Ceuta.

Lloret y Llinares S. Ltda., Agujero, Ceuta.

Manuel Ordonez Baró, General Franco, 20, Ceuta.

Pesquera del Mediterraneo, S.A., Almadraba, Ceuta.

SWEDEN

A.B. Alexporten, Ahus (Eel).

Sigvald Ankarhall, Stockholm.

A/B Boviks Konservfabriker, Lysekil.

A/B Bröderne Ameln, Stockholm 7. Prawns.

Dahlgrens Efterföljare, J. E. Jansson A/B, Karlstad.

Handelsaktiebolaget Belgas, Stockholm.

H. H. Kristensen, Göteborg. Caviar.

Lindblad & Persson A/B, Göteborg.

A/B Elis Luckeys Konservfabrik, Lysekil.

A/B Gust, Richter, Lysekil.

Scangothia Export-Import A/B, Göteborg.

Skandiakonserv, Hugo Hallgrens Konservfabriker A/B, Stockholm.

Stibergs Konservfabriker A/B, Göteborg 14.

Strömstad Canning Co. A/B, Strömstad. Brisling Sardines.

A/B Sveriges Förenade Konservfabriker., Göteborg. Caviar.

A/B Varjag, Stockholm.

Bengt Wrenke Atkiebolag, Stockholm.

SYRIA (BEYROUTH)

Panoyoty Anghélopoulo, Rue Souk El-Jamil, BP.13.

Massoud Frères, Rue Hoyek, B.P.21.

Idriss. Wafic, Place des Canons.

S. Krouk, Souk El-Jamil.

Michel Merhi, Souk Abou-Nasr.

Tanios Chémali, Bab Indriss.

Henry Halaby, Bab Idriss.

Tanios Chémali, Bab Idriss.

Fattouh Frères, Souk El-Jamil.

TUNISIA

Office Tunisien de Standardisation (O.T.U.S.), Avenue Jules Ferry, Tunis.

Ste Anonyme des Conserveries Tunisiennes (Sacot), 23 Rue des Glacières, Tunis.

Ste Franco Tunisienne des Conserves du Sahel, Sousse.

Martin Hecker, Route de Monastir, Sousse.

Ets. Sardal, Mahdia.

Zenzeri & Sfar, Mahdia.

UNITED STATES

Alaska Packers Assn., 11, California, San Francisco.

BALESTRIERI & CO., 123, Jackson Street, San Francisco 11, Calif. (See Section I and Advert.).

Booth Fisheries Corp., 309, W. Jackson Blvd., Payette, Idaho.

Biloxi Canning & Packing Company, P.O. Box 177, Biloxi, Miss. D. V. Santos (Pres.), A. O. Soares (Vice-Pres. and Gen. Manager).

Bridgeport Canfish Company (Division of Safeway Stores, Incorporated), 55, New Montgomery Street, San Francisco 5, California.

California Sea Food Corp., 107, Emerald Street, Redondo Beach, California. President: Myer Simon. Canners of Sardines, Mackerel and Tuna Fish.

Crawford Packing Co., Palacios, Texas.

California Packing Corp., 101, California, San Francisco.

Dehn & Co., Inc., Colman Bldg., Seattle 4, Washington.

Del Mar Canning Co., Monterey, Calif.

Forty Fathom Fish, Inc., 30, Fish Pier, Boston, Mass.

French Sardine Co. Inc., Terminal Island, Calif.

Gosse (F. A.) Company, Colman Building, Seattle 4, Washington.

Gorton-Pew Fisheries Co. Ltd., Gloucester, Mass.

Hovden Food Products Corp., Monterey, Calif.

Hunt Foods Inc., 1, Drumm., San Francisco.

Italian Food Products Co. Inc., Long Beach, Calif.

Kent Packing Company, Rock Hall, Maryland

Knight International Trading Co., 4996, Broadway, New York 34, N.Y. TA: "Knightnal." T: Lorraine 9-0707 Exporters of canned fish.

Maine Sardine Packers Export Association, 17, Battery Place, New York Cit, 4, N Y.

MAVAR SHRIMP & OYSTER CO. LTD., P.O. Box 66, Biloxi, Miss. (See Section 1 and Advert.).

New England Fish Co., 1715, Smith Towers, Seattle, Wash.

North Atlantic Packing Company, 80, Federal Street, Room 504, Boston, Mass D: E. Robert Kinney (Pres.), Paul M. Jacobs (Vice-Pres.), Arnold P. Mork (Sales Manager). Plant: Bar Harbor, Maine. Sales Office: Boston, Mass.

Pacific American Fisheries, Inc., South Bellingham, Wash.

Pearce (Frank C.), Co., Gloucester, Mass.

Peterson (Frank C.) Co., Dexter-Horton Bldg., Seattle.

Red Salmon Canning Co., Dexter-Horton Bldg., Seattle, Wash.

San Juan Fishing & Packing Co., Stacy & E. Waterway, Seattle.

Skinner & Eddy Corp., Skinner Bldg., Seattle.

Sun Barbor Packing Co., San Diego, Calif

Sutherland (David H.) Company, 203 American Building, Seattle 4, Washington. Exporters of Canned Salmon, Fisheries Supplies.

U S. Conserve Company, 6327, Theodosia Avenue, St. Louis 20, Missouri. President: E. N. Binder. Branches and Agents all over the U.S.A.

Vita Food Products, Inc., 644, Greenwich Street, New York 14, N.Y.

Westage Sea Products Co., San Diego, Calif.

Wesson Oil & Snowdrift Sales Co., 210, Baronne St., New Orleans, La.

West Coast Packing Corp., Long Beach, Calif.

Underwood (Wm.) Co., Watertown, Mass.

IV. MACHINERY AND EQUIPMENT FOR FISH PROCESSING, REFRIGERATION, ETC.

DENMARK

CONSERVES TEKNIK A/S, Ny Kongensgade 15, Copenhagen K. T: Central 1353. TA: "Conservator."

GREAT BRITAIN

Acme Engineering Co. Ltd., Stocks Hill, Leeds, 11. D: R. Wilkinson, M.I.W.E., N. H. Wilkinson, A. E. R. Wilkinson, D.S.C. Branches at London, Bristol, Newcastle, Cardiff, Birmingham, Gloucester. Fish Frying Equipment.

ALFA-LAVAL CO. LTD., Great West Road, Brentford, Middlesex. D: MacColl, H. H., Dolton, R. H., Mackegg, H. A: Throughout the World. Machinery and Equipment. (See advert.).

ARENCO LTD., 4, Carlisle Avenue, London, E.C.3. T: Royal 1693-4. Cables: Arencomek. D: A. Assheton Lowe, F.C.A., T. Lyth (Swedish) and D. Dixon, A.I.E.E. Machinery for Fish Nobbing and Gutting, etc. (See advert.).

Beldam Asbestos Company Limited. Head Office and Works: Hounslow, Middlesex, England. (Hou. 6441); City Office: 80, Bishopsgate, London, E.C.2.

Bonaccord Press Tool Co., St. Clair Street, Aberdeen. T: 2365 Aberdeen. TA: 2365 Aberdeen. D: Charles Sangster, Geo. B. Sangster, Charles Sangster, Junior.

BRITISH CORK MILLS LTD., 167, Victoria Street, London, S.W.1. (See Section 5).

EDWARDS (F. J.), LTD., 359/361, Euston Road, London, N.W.1. Works situated at Chard, Somerset; Loughborough, Leics. Can Making Machinery. (See advert.).

A: South Africa—Rogers, Jenkins & Co., (Pty.) Ltd., P.O. Box 654, Johannesburg; P.O. Box No. 1425, Cape Town; P.O. Box No. 1876, Durban, and P.O. Box No. 657, Port Elizabeth, Cape Province. Faroe Islands—G. Helgason & Melsted (Reykjavik). A/S Filial Thorshavn, Thorshavn. New Zealand—Levin & Co. Ltd., Anzac Av., P.O. Box 63 Auckland. **Iceland**—Njall Thorarinnson, P.O. Box 971, Reykjavik; **Mexico**—The General Supply Co. S.A., Plaze de la Republica 46, P.O. Box 1433, Mexico, D.F. **Egypt**—Artine Spendjian, 15, Rue Emad El Dine, Cairo, and 5, Rue Dare du Caire, Alexandria. **Switzerland**—Heinrich Reimann, Heuelstrasse 35, Zurich 7. **Palestine** Josef Rosenthaler, 17, Ne'emanim Street, P.O. Box 791, Haifa; 25, Alfasi Street, Jerusalem, and 22, Merkaz Mishari Street, Tel Aviv. **Sweden**—Maskinaktiebolaget Karlebo, Kungsgatan 33, Stockholm; O. Hamngatan 14, Goteborg; and Gust Adolfs Torg 10, Malmo, Sweden. **Syria and Lebanon**—Richard A. Abdun-Nur, P.O. Box 868, Beirut. **Holland**—Gosselaars Metaalhandel, Plantage Doklaan, 3, Amsterdam, C.

THE FARRAR BOILERWORKS LTD., Farramatic Department, Newark-on-Trent. T: Newark 1143-4-5. TA: "Farramatic, Newark." D: H. A. Sisson, O.B.E., M.A., F.C.A. (Chairman), John E. Palmer, M.I.B.E. (Man. Dir.).

Branches and Agents: **Scotland**—Morris Warden & Co. Ltd., 90, Mitchell St., Glasgow, C.1. **Africa (South)**—Reunert & Lenz Ltd., P.O. Box 92, Berresford House, Johannesburg. **Africa (East)**—The East African Eng. & Trading Co. Ltd., Dar-es-Salaam. **Australia**—G. E. Todd & Co. (Pty.) Ltd., Chatsworth House, 1-7, Bent St., Sydney. **Argentine**—Noble & Vallejos Boidi S.R. Ltda., Avenida Velez Sarsfield 1160, Beunos Aires. **Canada (East)**—Silver's Agencies Ltd., Pickford's and Black's Wharf, Halifax, Nova Scotia. **Egypt**—M. Tahry, General Engineering and Refrigeration Co., 9, Adly Pasha, Cairo. **Iceland and the Faroes**—Findlay Durham and Brodie, 6, Bloomsbury Square, London, W.C.1. **India (North)**—Balmer Lawrie & Co. Ltd., 103, Clive St., Calcutta; 5, Graham Road, Ballard Estate, Bombay. **India (South)**—Binny & Co. (Madras) Ltd., 7, Armenian Street,

Madras. **Malta**—The General Trading Co. Ltd., 303-305, Kingsway, Valetta. **Mexico**—Casa Molina Font, Apdo Postal 8719, Mexico D.F. **New Zealand**—J. J. Niven and Co. Ltd., 65-67, Taranaki St., Wellington. **Palestine**—M. Amity, Esq., 26, Jaffa Tel-Aviv Road, P.O. Box 4042, Tel-Aviv. **Portugal** — Metalurgica do Socorro Ltd., 202, Rua Da Palma, 204, Lisbon. **Syria**—Constructions & Enterprises Industrielles, Rue Bustan Gal-Ab, P.B. 193, Aleppo. **Turkey**—"Marsa" Societe Anonyme Turque, P.O.B. 1531, Instanbul. **West Indies**—Wadley Manufacturing Co. Ltd. (J. B. Guisto, Bogota, Colombia, Coventry House, South Place, London, E.C.2. **(See Advert)**.

Feaver (John), Ltd., 120, Tower Bridge Road, London, S.E.1. D: J. W. Feaver, L. E. Feaver, H. G. Feaver. Fish Cans and Canning Machinery.

FRESH FROZEN FOODS LTD., Irvine, Ayrshire, Scotland. T: Irvine 2283. Equipment for Processing and Refrigeration. (See Section 1 and Advert.).

Frigidaire (Division of General Motors Ltd.), 401, Edgware Road, The Hyde, London, N.W.9. T: Colindale 6541. Machinery and equipment for Fish processing, refrigeration, etc.

The Fullers' Earth Union Ltd., Caer-Laverock, Nutfield Road. Redhill, Surrey. D: Sir Bertram T. Rumble (Ch.), W. S. Gray, John L. Harvey, M.B.E., L. P. O'Brien, F.C.I.S., W. T. Raikes, D.S.O. Fullers' Earth (Activated) for Fish Oil Refining.

"GREYHOUND" PAINT & COMPOSITION CO. LTD., Amberley House, Norfolk Street, Strand, W.C.2. D: Sir Hugh Rose, Bt., Malcolm J. Henderson, H. D. Holland-Ramsay, R. Russell French. A: All World Ports. (See Advert).

HALL, (J. & E.) Ltd., Dartford, Kent. TA: Halford, Dartford. T: Dartford 3456. London Office: 10, St. Swithin's Lane, E.C.4. TA: Hallford, Phone, London. T: Mansion House 9811. Codes: A.B.C. 5th and 6th Eds., Bentley's, Scotts, Western Union, Private. (See Advert). Branch Addresses in the British Isles: 127, Victoria St., Bristol; 9, Lower Mosley St., Manchester, 2; 264, Broad St., Birmingham, 1; Messrs. Morris, Warden & Co. Ltd., 90, Mitchell St., Glasgow, C.1. Manufacturers of Refrigerating and Ice-making Machinery for Land and Marine use; "Hallmark" Automatic Refrigerating Equipment, Escalators and Lifts. Overseas Agents and Representatives: **Africa—Belgian Congo:** Compagnie des Produits des Frigoriferes du Congo, Matadi, Congo Belge. **Africa—East:** G. B. Nicholas & Co. Ltd., P.O. Box 297, Mombasa, Kenya Colony, and P.O. Box 537, Nairobi, Kenya Colony. **Africa—South:** Reunert & Lenz Ltd., P.O. Box 92, Johannesburg; also P.O. Box 2073, Cape Town. **Argentine Republic:** A. G. Pruden & Co., Calle Bouchard 680, Buenos Aires. **Australia, Whole of:** Amalgamated Wireless (Australasia) Ltd., Wireless House, 47, York Street, Sydney, N.S.W.; Malcolm Moore Ltd.. Williamstown Road, Port Melbourne, SC.7. **Belgium and Luxemburg:** H. Dechaineux et Cie., Rue Montagne, Aux Anges 25, Brussels. **Brazil:** H. C. Aspinall, P.O. Box 415, Rio de Janiero. **Canada:** Vancouver Engineering Works Ltd., 519-639, Sixth Avenue West, New Cambie Street South, Vancouver, B.C.; Eastern Steel Products Ltd., 394, Symington Av., Toronto 9, Ont. **Chile:** Monckton & Co. Ltd., Castilla 1445, Valparaiso; Hendry Bros. (London) Ltd., 175-7, Salisbury House, London, E.C.2. **Cyprus:** B. C. Petrides & Co., P.O. Box 91, Nicosia. **Denmark:** Helweg-Jorgensen, G. Kongevej 74, Copenhagen. **Eire:** Irish Cooling Equipment Ltd., 28 29, St. John Rogerson's Quay, Dublin. **Finland:** Oy. Gronblom Ab., P.O. Box 370, Helsingfors. **Holland:** N.V. Internationale Nautische Handel-Maatschappij, Van Zaeckstraat 45, Den Haag. **Iceland:** Gisli Halldorsson Ltd., P.O. Box 352, Reykjavik. **India (Bombay and West):** Gannon Dunkerley & Co. Ltd., Chartered Bank Building, Fort. Bombay (No. 1); (Calcutta) Jessop & Co. Ltd., 93, Clive Street, Calcutta; (Madras) Binny & Co. (Madras) Ltd., Madras. **New Zealand:** Ellis, Hardie, Symington Ltd., P.O. Box 793, Wellington, and P.O. Box 629, Auckland. **Northern Ireland:** Charles V. Hill Ltd., 5-7, Queen Street, Belfast. **Palestine:** Mr. E. Herz, P.O. Box 3034, Tel-Aviv. **Portugal:** The Engineering Co. of Portugal Ltd., Rua dos Remolares 12, Lisbon. **Spain:** "Dugopa" S.L., Plaza de las Cortes 5, Entresuelo, Madrid; Anglo Espanola de Electricidad, S.A., Av., Jose Antonia, Cortes 5, Barcelona (II). **Straits Settlements, Malay States,**

etc; Alliance Engineering Co. Ltd., 6-7, Telegraph Street, Singapore. **Sudan:** The Sudan Mercantile Co. (Engineers) Ltd., Khartoum. **West Indies and Central America:** S. K. Watson & Co. Ltd., P.O. Box 605, Port of Spain, Trinidad. **Antigua:** G. W. Bennett Bryson & Co. Ltd., St. John's. **Barbados:** Barbados Foundry Ltd., White Park Road, Bridgetown. **Bermuda:** Bermuda Electric Light, Power & Traction Co., Ltd., Front Street West, Hamilton. **British Guiana:** Booker Bros, McConnel & Co., Ltd., Georgetown, Demerara. **Jamaica:** The Kingston Industrial Agencies, 1, Darling Street, Kingston, Jamaica. **St. Kitts:** E. S. Delisle, Basseterre. **St. Lucia:** Minvelle & Chastenet Ltd., Castries.

Kelvin, Bottomley & Baird Ltd., Henry Hughes & Son, Ltd., Associated as Marine Instruments Limited, 107, Fenchurch St., London, E.C.3. D: Sir Allan Gordon Smith, K.B.E., D.L., F. A. King, A.M.I.E.E., A. J. Hughes, O.B.E., F.R.A.E.S., A. A. King, M.I.Chem.E. Machinery and equipment for fish processing, refrigeration, etc.

Kelvinator Ltd., Pym's Lane, Crewe, Cheshire. D: L. G. Hawkins, E. A. Roden, A. E. Carter (U.S.A.), R. H. Oxley, G. W. Mason (U.S.A), H. A. Lewis (U.S.A.), R. A. De Vlieg (U.S.A.). Branches and Agents: 42 in the British Isles.

New Standard Cold Storage (Aberdeen) Ltd., Raik Road, Aberdeen.

Payne & Griffiths Limited, Tudor Works, Windmill Lane, Smethwick, Birmingham. T: Smethwick 1518. TA: Thermal, Birmingham. A: In most countries.

Pertwee & Back Ltd., Nelson Iron Works, South Quay, Great Yarmouth. D: Victor W. Back, M.I.Mar.E., F. M. Back. Ice Crushing Machines.

Peter Brotherhood Ltd., Peterborough. T: Peterborough 2251 to 4; TA: Brotherhood, Peterborough. D: A. M. Neal (Ch.), W. T. Freestone, Eng. Rear Admiral F. G. Haddy, E. Markham, S. J. Bellamy and W. Thompson. B: London, Leeds, Manchester. A: At Bristol, Swansea and most countries overseas.

Pressed Steel Co. Ltd., Cowley, Oxford. Refrigeration Machinery and Equipment.

Refrigerator Contracts Ltd., 111/113, Randall St., Sheffield, 2. D: R. Hammersley (Managing), N. C. Peel, J. Merifield (Sec.) Branches: 105, Beverley Rd., Hull, and 1a, Cleethorpe Rd., Grimsby.

ROGERS (J. L.) & STAFF, Abbey House, Victoria Street, London, S.W.1. Specialist Consultants in Quick Freezing. (See advert.). Lawrie. Marine Ventilation and Fan Makers.

Rouse (John) (Oldham) Ltd., Enterprise Works, Booth Street, Oldham, Lancs. D: J. Dawson, H. Simpson, A. Simpson, E. L. Thompson. Potato Peeling Machines.

Rowton Engineering Co. Ltd., South Esplanade, West, Aberdeen. D: H. S. Rowton, J. L. Rowton, C. Shaw.

SLINGSBY (H. C.), 89/97, Kingsway, London, W.C.2. E: 1893. Trucks for barrel handling and transport. (See advert.).

Whitaker (C. L.) & Co., Humber Bank South, Fish Docks, Grimsby. T: 2183. P: C. L. Whitaker, A. W. Whitaker. Cold Storage Insulators.

Winsor Engineering Co. Ltd., Earl Haig Road, Hillington, Glasgow, S.W.2. D: J. Marshall, J. C. Turnbull, A. E. Lawrie. Marine Venilation and Fan Makers.

UNITED STATES

Electric Fly Screen Company, Inc., 430, West Hoffman Avenue, Lindenhurst, Long Island, New York. D: R. Goelbert (Pres.), E. Goelbert (Vice-Pres.), M. L. Kirby (Sec. Treas.). Branch: 669, 8th Avenue, New York, N.Y.

Gotham Instrument Co., Inc., 149, Wooster St., New York City. D: Walter J. Halpern (Pres.), Robert Hamerschlag (Vice-Pres.), James P. Henderson (Gen. Mgr.).

Knowles Associates, 19, Rector Street, New York 6, N.Y. D: C. L. Knowles R. C. Ried, O. R. Kuster. Engineers Oil and Meal By-Products.

Pilgrim Refrigeration Co., 48-50, 43rc Avenue, Long Island City, N.Y. P David B. Bartelstone, Julian L Bartelstone. Machinery and Refrig erating Equipment.

Machinery & Equipment Co., 705, Bran nan St., San Francisco 3, California Fish processing and packing equip ment, and packing materials.

Weksler Thermometer Corp., Expo Division, 11, West 42nd Street, Ne York 18. Thermometers for industri needs.

V PACKING MACHINERY, MATERIALS, ETC.

GREAT BRITAIN

AVIATION DEVELOPMENTS LTD., Kingbourne House, 229/231, High Holborn, London, W.C.1. T: Chancery 8601 (8 lines). TA: Avidev, Holb., London. Regd. Office and Factory at 2, Woodfield Rd., Welwyn Garden City, Herts. T: 3881 (6 lines). MD: Stanley T. Johnson. D: Sir Alliot Verdon Roe, O.B.E., F.R.Ae.S. (Ch), E. M. Bettington, O.B.E., B.Sc., Frank Lanes, J. E. Gibson, C.A. (Edin.), and A. L. Shearer, M.A. (Hon.). Manufacturers of Aluminium Fish Boxes. (See advert.).

Gorrod (George) & Sons, 41, Regent Quay, Aberdeen. D: John L. Gorrod, George Gorrod. Coopers and Cooperage Material.

HULL MERCHANTS' AMALGAMATED BOX CO. LTD., Dairycoats, Hull, Yorks. T: 37786. TA: Cabox. D: S. E. Allenby, W. Boyd, J. N. Colley, G. Gillard, T. H. Jackson, T. W. Jervis, K. Percival, R. Willey. Gen. Man: C. W. Saunders. Manufacturers of all types of boxes for the fish trade, etc. (See advert.).

MORRISONS ENGINEERING, LTD., Works: The Airport, Rochester, Kent. London Office: 11, Upper Grosvenor Street, London, W.1. D: G. P. McGiveney, D. McIntyre Proctor, A. E. Morrison-Bell, A. Bernstein. A: Cory Bros., & Co. Ltd. (See Advert.)

Mauritzen (Charles) Ltd., 14-15, Quality St., Leith, Scotland. (See Section IV).

Sack & Bag Industries Ltd., Pee Grove, London, E.2. T: Advance 3540 and 1261. TA: Sackindus, Beth, London. Sacks and Bags.

The Smith Printing & Paper Co., 38, Hessle Road, Hull. Printers and Paper Merchants; Linings for Fish Boxes.

THOMAS (W. K.) & CO., 27, John Adam St., London, W.C.2. D: W. K. Thomas. Packing Materials. (See Advert.).

WEST DOCK TIMBER CO. LTD., Manchester Street, Hull. D: J. E. Tether, W. C. Ashton, S. C. Tether, W. J. Robins, W. H. Ashton and W. R. Atkinson. (See advert.).

NETHERLAND

Dorp (J. C. van), & Zonen, Vetteoordskade 7/13, Vlaardingen. D: D. N. van Dorp, K. W. van Dorp, J. C. van Dorp. Fish Barrel Factory.

UNITED STATES

Firstenberg Bottlers Equipment Vo., 301-307, Powell St., Brooklyn, 12 N.Y. T: Dickens 2-1021-2. TA: Firsupply New York. E: 1892. MD: Clarence D. Firstenberg. Machinery and equipment for packing, processing and refrigeration.

United States Barrel & Drum Copr., 400, Madison Avenue, New York 17. (Executive Offices). New and used barrels and drums, shipping containers for the fisheries industry, exporters.

VI. SUPPLIES FOR FISHERIES

Ship Builders and Repairers, Ship Chandlers, Nets and Cordage, Instruments and Other Equipment

AUSTRALIA

Botterill & Fraser, Corner of Hanna and Kavanagh Streets, Melbourne, Vic. D: J. Botteril, C. H. Fraser.

Kennison (John E.), 321, Marilbyrnong Road, Ascot Vale, Melbourne, W.2. Fishing Tackle Manufacturers.

UNION GUT COMPANY PTY. LTD., Tyabb Rd., Mornington, Victoria. TA: Uniongut, Melbourne. Gut Fishing lines, guaranteed non-kinkable. (See advert.).

DENMARK

BURMEISTER & WAIN, Copenhagen. Shipbuilders. (See advert.).

ICELAND

LANDSMIDJAN, The Government Engineering Works, Reykjavik. M: O. Sigurdson. Ship Repairs, etc. (See Advertisement).

GREAT BRITAIN

The Ardrossan Oilkskin & Waterproofing Coy. Ltd., Ardrossan, Ayrshire. Oilkskin Clothing Manufacturers.

Beetons Ltd., Sunrise Net Works, Lowestoft. D: E. H. Beeton, Eric N. Beeton.

Bembridge & Jenkins Ltd., 197, Heneage Street Birmingham. D: D. B. Jenkins, A.C.A. R. T. Jakney, F.C.A., E. E. Jenkins. Birmingham and Liverpool; Agents at Home and Abroad.

BENN (CHARLES) & SONS, LTD., Vulcan Foundry, Stourton, Leeds, 10. D: Mr. Clifford Landale Benn, Mr. Charles Henry Benn.

BLOOMFIELD'S LTD., Great Yarmouth. T: 2291. TA: Ocean. Ship Chandlers, Fishing Vessel Owners and Ship Brokers, Ice Manufacturers, Cold Storage Proprietors, Coal and Salt Merchants. (See advert.).

The Blyth Engineering Co. Ltd., South Harbour, Blyth, Northumberland. MD: T. Bateman. T: Blyth 39. Marine Engineers and Ship Repairers.

Bolinders Co. Ltd., 4, Lloyds Avenue, London, E.C.3. D: Scott, J. M., Mackley, W. C., Larnell, Bengt. A: P. J. Kavanagh, 33, Clarendon St., Dublin, Eire. Engine Makers.

Bovack, Barclay & Co., 38, Cowgate. Dundee. Angus. D: Laurance Barclay, Ronald Barclay.

BRITISH CORK MILLS, LTD., 167, Victoria Street, London, S.W.1. D: S. M. Agelasto, S. A. Dohm, J. I. Piggott. A: World Wide. (See Advert).

British Ropes Limited, Carr Hill, Balby, Doncaster, Yorkshire. D: Herbert Smith (Chairman), Enos Smith, A. R. Allan, Fred Ellis, William Haggie, A. P. Smith, F. Richardson, Harry Smith, E. F. Wigzell.

DANIEL BUCHANAN & SONS, Preston Works, Prestonpans. D: George E. C. Buchanan, A. Buchanan. A: Messrs P. A. Johannessen, A/S, Aalesund, Norway; Messrs. W. Van der Toorn & J. C. Pronk, Scheveningen, Holland. (See Advert.).

Bull's Metal and Melloid Co. Ltd., Yoker, Glasgow, W.4, Scotland.

Butt Bros. (Fish Salesmen) Ltd., Auckland Road, Fish Docks, Grimsby. D: Albert W. Butt. G. W. Butt, Arthur W. Butt and W. W. W. Butt. TA: "Butt Grimsby." Trawler Managers, Fish Salesmen, Brokers and Agents.

CALEDONIAN FISHSELLING & MARINE STORES CO. LTD., 11, Harbour Street, Peterhead. T: 414/5. TA: Caley. Branches at Great Yarmouth and Fraserburgh. Everything for Fishing Boats. (See advert.).

Carter, J. H., 16, Butts Road, Walsall.

Cochrane & Sons, Limited, Ouse Shipbuilding Yard, Selby. D: A. L Cochrane, D. M. Cochrane, S. J. Cochrane, V. Gray. Branch: Prince's Dock, Hull. Shipbuilders.

Cook, Welton & Gemmell Limited, Grovehill, Beverley, E. Yorks. T: Bev. 18, 758 and 84. TA: Gemmell, Beverley. D: Harold E. Sheardown (Chairman), Ambrose Hunter (Managing Director), Francis G. B. Gemmell. Fitting-out Branch: Princes Dock, Hull. Shipbuilders.

Cowie, (Adam A.), Branch of United States Metallic Packing Co., Ltd.), 300, Great Northern Road, Aberdeen. D: As Head Office, Soho Works, Allerton Road, Bradford. Ship and Engine Builders and Repairers. Speciality: Metallic Packing Manufacturers and Repairers.

Crabtree (1931) Ltd., Southdown Ironworks, Gt. Yarmouth. Marine Engineers.

Crosbie (Adolphe) & Co., Walsall Street Paint and Colour Works, Wolverhampton. Pr: John Bill.

Darroch & Espie, Ltd., Dock Works, Weir Street, Glasgow, C.5. D: J. W. Stewart, M. R. Stewart, W. W. Miller, Wm. Black. B: 44, Brand St., Glasgow, S.W.1. Blockmakers and Ship Repairers.

Diamond Boat Building Company., West Side, East Dock, Cardiff. Pr. G. M. Cazenave (Mrs.). Manager: D. L. Anstee.

Drifters (Peterhead) Ltd., 11, Harbour Street, Peterhead. D: R. Forman, C. Forman, W. J. Bruce.

Duolux Buoylamp Company, Grimsby Docks. P: Harry Crampin, Herbert W. Crampin, F.C.I.S. Also electrical engineers and makers of marine Radio equipment.

Electric Welded Chain Co. Ltd., Cemetery Road, Lye, Stourbridge. D: P. J. Darby, Senr., P. J. Darby, Jnr., M. D. Darby. Chains, Shackles, Thimbles.

Fishermen's Supply Store, Shore Street, Anstruther. D: L. W. Robertson, J. R. Taylor, A. S. Bonthron and D. Moncrieff.

FORESTAL LAND, TIMBER & RAILWAYS COMPANY LTD., Regis House, King William St., London, E.C.4. A: (See Advert.). Suppliers of "Calda" Cutch for proofing nets. (See advert.).

Agents: Beetons Ltd., Sunrise Net Works, Lowestoft. **Belgium** — Cie. Belge des Cuirs et Tanins S/A., 16, Rue de Jesus, Antwerp. **Finland**—Oy. Mercantile A/B., Helsinki. **Greece**—F. E. Rose (London) Ltd., 1, Pepys Street, London, E.C.3. **Holland**—Van der Toorn's Im-en Exporthandel C.V., Treilerweg 74-76, Scheveningen. **Norway** — Norsk Argentinsk Handelskompani, Akt., Store Markevei 3, Bergen. **Portugal**—Mr. Lino Teixeira de Carvalho, Rua dos Bacalhoeiros 155 A., Lisbon.

Fellows & Co. Ltd., Southtown Dry Docks, Gt. Yarmouth. MD and Sec.: J. M. Fellows. Shipbuilders.

Forth & Clyde Roperie Coy., Esplanade, Kirkcaldy, Scotland. P: Thomas Renton. A: In Iceland.

Franklin (Harry), Ltd., Cross Street, Fish Docks, Grimsby, Lincs. T: Grimsby 3754. TA: Franklin, Grimsby. D: H. N. Franklin, C. G. Franklin. Makers of Seine Nets.

GIBSON JOHNSTON LTD., 5, Bowlalley Lane, Hull. Ship Sale and Purchase Brokers. T & TA: Hull 36793. (See advert.).

Glen Boatyard, Bangor West, Co. Down, Northern Ireland. Fishing Boat Builders and Repairers.

Gleniffer Engines Ltd., Strathcona Drive, Anniesland, Glasgow, W.3. D: Colin H. Macmillan, B.Sc. (Man. Dir.). Engine Makers.

GT. GRIMSBY COAL, SALT & TANNING CO. LTD., Fish Docks, Grimsby. T: 5346 Grimsby (4 lines). TA: Carter, Grimsby. (See Advt.)

"GREYHOUND" PAINT & COMPOSITION CO. LTD., Amberley House, Strand, W.C.2. (See Sections 4 and 5).

GUNDRY (JOSEPH) & CO., LTD., Bridport, Dorsetshire. Nets and Cordage for Fisheries. (See Advt.).

Hall, Russell & Co. Ltd., York Place, Aberdeen. D: Sir Wilfrid Ayre. Ch: Howard Johnson. MD: C. S. McLay.

R. Hood Haggie & Son, Ltd., Newcastle-on-Tyne, 1. A: World-wide. Rope Makers.

Hayward (Richard) & Co. Ltd., The Coker Sailcloth Works, Crewkerne, Somerset. D: C. R. Hayward, R. C. Hayward, J. R. C. Hayward, G. K. Hart, A. S. C. Hart, D. G. Hart, A. G. Fyfe. Sailcloth, Canvas and Twines.

N. Holman & Sons, Ltd., Dry Dock, Penzance, Cornwall. D: F. W. Holman, E. B. Holman, P. D. Holman, W. Holman, F. L. Holman. Ship Repairs.

Hutchison & Pollok Ltd., Mersey Ropeworks, Lodge Lane, Liverpool 8. D: W. B. Adam, W. L. R. O'Brien. Cordage Manufacturers.

International Marine Radio Co. Ltd., (Reg. Office) Connaught House, 63, Aldwych, London, W.C.2; (Executive Offices) 25-26, Lime St., London, E.C.3. D: H. Thorpe-Woods (Managing).

INTERNATIONAL PAINT & COMPOSITIONS CO. LTD., Grosvenor Gardens House, London, S.W.1. (See Advt. on Front Cover).

Icelandic Trading Corporation Ltd., Nevill House, Railway Approach, London, S.E.1. T: Hop. 1706. TA: Iceltrade, Boroh, London. D: H. Sthyr, A. Trier, H. Behrendt.

Improved Submerged Log Co. Ltd., Parliament Mansions, Abbey Orchard Street, Westminster, S.W.1. D: C. C. Barker, W. R. Beldam, A. Petroff and J. W. Moffatt. A: Aberdeen, Fleetwood, Grimsby, Hull, Milford Haven and Reykjavik, Iceland.

JORDAN (HENRY) & SON, 7, Salthouse Lane, Hull Yorks. T: 36379. TA: Sails, Hull. E: 1817. Canvas goods of every kind for trawlers. (See advert.).

Kelly, Booth W., Shipyard, Ramsey. P: Booth W. Kelly. Ship and Boiler Repairers.

KERSHAW-SOHO (SALES) LTD., 37-41, Mortimer Street, London, W.1. T: Museum 1033. TA: Noiran Wesco, London. A: All over the world. Binocular Manufacturers. (See advert.).

Keys (W. H.) Ltd., Hall End Works, West Bromwich. D: Major H. Wilson Keys, Mr. F. W. Rogers, Mr. A. E. Williams, Mr. W. E. Hatton. Marine Glue and Bituminous Solutions.

Kincaid (John G.), & Co. Ltd., 18, East Hamilton Street, Greenock. D: Randal G. Kincaid, Sir Alfred H. Read, Alfred Davis, O.B.E., Alex. M. Paterson, Robert Greer. Marine Engineers.

L.B.S. Engineering Co. Ltd., Hamilton Road, Lowestoft. Ship Repairs.

Lamont (James) & Co. Ltd., Dock Breast, Greenock. D: E. W. Macfarlane, I. C. Macfarlane, C. A. Ross, Wm. Raeside. Branches at Greenock and Port Glasgow. Shipbuilders and Repairers.

Leigh Boat Building Works, 17, High Street, Old Town, Leigh-on-Sea, Essex. D: Lt. Commdr. W. A. Ellison, R.D., R.N.R. B: 3, Southwark Street, London, S.E.1. Boat Builders and Repairers.

Lewis (James D.), Electrical Engineers, 42-43, Lower Branton Road, Edinburgh 5.

Lorimer (R. Glen) & Co., 231, St. Vincent St., Glasgow, C.2. P: Lorimer (R. Glen). Paints for Ships.

Marine Instruments Ltd., 107, Fenchurch St., London, E.C.3. D: Francis Hughes (Overseas Director). A: All U.K., *fishing ports and overseas*. Instruments for Fisheries.

Marine Services Limited, 14, Lower Donegall Street, Belfast; and Boatyard, Portavogie, Co. Down. D: John George McCann, E. G. McCann. Boat Builders, Repairs, Marine Engineers.

Massey (W. A.) & Sons, Ltd., Quay Street, Hull. (*Also at Grimsby*, Immingham and Goole. Ch and Gov. D: B. S. Massey. Brokers for Sale of Fishing Vessels.

Mathews Maclay & Manson Ltd., Hydepark Paint Works, 138, Hydepark St., Glasgow, C.3, Scotland. D: David A. Service, A. D. Cameron. A: Principal U.K. Ports. Marine Paints and Ship's Bottom Compositions.

Charles Mauritzen Limited, 14-15, Quality St., Leith. D: C. R. Mauritzen (Managing), H. H. Mauritzen, E. F. Baker, R. S. G. Melvin. Branch: Aberdeen.

MIDDLETON (R. L.) LIMITED, Maclure St., Grimsby Fish Docks. D: Joseph Broughton Middleton, Henry Cecil Lucas, John Arthur Middleton. A: At Norway, Denmark, Sweden, Iceland, South Africa. All Supplies for Fisheries. (See Advt.).

Morris (J. S.), Boatbuilder, Ship Repairer and Saw Miller, 6, Lombard St., Port Madoc, N. Wales.

MUNSTER, SIMMS & CO. LTD., (Est. 1810), Imperial House, Donegall Square, E., Belfast. D: C. W. Eves, C. M. Simms, G. F. Greeves and D. W. Eves. Manufacturers of Marine Equipment. (See advert.).

PHILLIPS' FAMOUS FLOATS

MODELS MADE FOR EVERY TYPE OF FISHING

THE SEINE NET FLOAT

and

THE NORTH SEA FLOAT

for

Shallow Water

The Patent ALUMINIUM ALLOY FLOAT

and

The Patent "PHILTRA" HARD STEEL FLOAT

for Deep Water

PHILLIPS TRAWL PRODUCTS LTD.

Manufacturers under Royal Letters Patent

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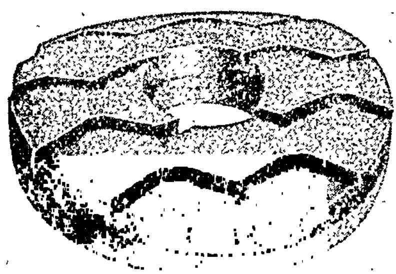
GRIMSBY, ENGLAND

'Phone : GRIMSBY 4484 'Grams : BUOYANCY, GRIMSBY

THE RUBBER FOOTROPE DISCS

DISCS
3½in. dia.
4in. dia.
4½in. dia.
5in. dia.
6in. dia.



HOLES
1¼in. dia.
1¾in. dia.
2in. dia.

ROLL DISCS LIMITED

248/252 KING EDWARD STREET NORTH,
GRIMSBY, ENGLAND

'Phone : GRIMSBY 3801 'Grams : PRESSCUT, GRIMSBY

The National Gas & Oil Engine Co. Ltd., Ashton-under-Lyne. D: Visct. Falmouth, A. B. Balmford, B.A., M.I.M.E., H. C. Bickerton, Major F. W. Cundiff, Lt.-Gen. Sir W. G. Lindsell, G.B.E., K.C.B., D.S.O., M.C. A: All over the World.

Nicol (A.) & Co. Ltd., Chalmers Street Works, Arbroath, Angus. Canvas.

Norstand Ltd., Humber Bank, Fish Docks, Grimsby. D: A. W. Butt, Geo. W. Butt, G. Clarke. Ship Repairers.

Olsen's, Fish Dock Road, Grimsby, Lincs. T: 2379 and 61913. Nautical Instrument Makers and Compass Adjusters.

PHILIPS TRAWL PRODUCTS LTD., King Edward Street North, Grimsby. T: 4484. TA: "Buoyancy." Floats, Trawl Supplies, etc. (See Advt.).

Pryce (R. J.) & Co., Suffolk Road, Lowestoft. P: R. J. Pryce, H. R. Pryce, A. V. Pryce.

PYE LTD., Cambridge. Radio Telephone Equipment for continuous inter-communication for Fishing Fleets, Tugs, and short range marine work. (See advert.).

REDIFFUSION LIMITED, Broomhill Rd., Wandsworth, London, S.W.18. Ch: Sir Ronald W. Matthews. D: P. Adorian, J. Clayton, A.C.A., B. St. John Sadler (Man. Dir.), Sir Samuel Wakefield, M.P., F. Youle (Sales Dir.). Manufacturers of Radio Communication Equipment. (See Advt.).

Ross (F. & T.) Ltd., West Dock Avenue, Hull. Ship Chandlers.

SCHERMULY PISTOL ROCKET APPARATUS, LTD., Regd. Office: Spra Works, Newdigate, Surrey; Sales: 51, Coleman St., London, E.C.2. A: Represented by Stocking Distributors in all principal British Ports and in 25 countries in the world. (See advert.).

SHELL CHEMICALS LTD., 122, Strand, London, W.C.2, and 4, St. Mary's Parsonage, Manchester. T: Tem. 4455. Manufacturers of "Teepol" for dirt removal, etc. (See advert.).

The Shields Engineering & Dry Dock Co. Ltd., North Shields. D: R. Irvin, A. M. Meikle. T. S. Read.

SHIPPING & TRAWLING SUPPLIERS LTD. The Docks, Milford Haven. (See advert. and Section 2).

Sisson (W.) & Co. Ltd., Sisson Road, Gloucester. D: Col. R. K. Morcom, C.B.E. (Ch.), W. N. Hallett, M.I. Mech.E (V. Ch.), P. S. Fowler, M.I.Mech.E. (Managing), H. A. Sisson, M.A., O.B.E., F.C.A., F. V. Everard, M.I.Mech.E. Fisheries—Engine Makers (Steam).

SKARSTEN MANUFACTURING CO. LTD., 1, Hyde Way, Welwyn Garden City. D: A. Skarsten, K. Sheppard. Machinery and Equipment for Fish Processing, etc. (See advert.).

Smith's Dock Co. Ltd., North Shields, and South Bank, Middlesborough. Ship Builders, Engine Builders and Ship Repairers.

Stream-Line Filters, Ltd., Ingate Place, London, S.W.8. T: Macauley 1011. D: C. S. Garland, F. H. Rogers, H. Talbot, I. L. Triggs. A: In all countries. Makers of Oil Filters.

Sutherland (J. S.) & Co., 33, Cowgate, Dundee, Scotland. D: McGavin, D. R.

Swinsons Engineering Works (Props. Alister Kirk Co. Ltd., Ballarat St., Belfast. D: J. F. Stevenson, T. S. Graham. Winch Manufacturers.

Thurso Fishselling Co., The Harbour, Thurso, Caithness. TA: Fisheries, Thurso. T: 225. D. John Sinclair, James Mackay. Ship Chandlers.

TIMPSON (WILLIAM) LTD., Empiric House, Manchester, 3. D: W. H. F. Timpson, N. M. Timpson, A. G. Timpson, R. B. Booth, E. T. Hawthorne, G. A. Kester, R. P. Whipp, F. J. Noakes, W. A. Timpson. A: All parts of England and Scotland. Boots — and Rubber Boot Repairs. (See Advt.).

Thompson (Ingram) & Sons, Ltd., 7, Rumford Street, Liverpool, 2, and Salt Works, Northwich, Cheshire. D: J. I. Thompson, A. K. Thompson.

TOUGH (ALEXANDER) & SON, Clyde Rope Works, Greenock. P: William Alexr. Geo. H. and John S. Tough. A: Aberdeen, Grimsby, London, Liverpool and Cardiff. See Advert.

VICKERS - ARMSTRONGS LTD., Vickers House, Broadway, London, S.W. T: Abb. 7777. Engineers and Shipbuilders. (See Advert.).

WALKER (THOS.) & SON, LTD., 58, Oxford Street, Birmingham. T: 5474. TA: Shiplog. Makers of the "Trident" Electric Log, etc. (See advert.).

Wallsend Slipway & Engineering Co. Ltd., Wallsend-on-Tyne. B: London —34, Gt. St. Helen's, E.C.3.; Liverpool—Cunard Building. Oil Burning Machinery for Trawlers.

Watts, Fincham (1932) Ltd., 2, Great Winchester Street, London, E.C.2. Branch Store: 12-18, St. Anne Street, Liverpool. Ship Chandlers.

WEBSTERS LIMITED, New Cleveland Street, Hull. T: Central 33868 (2 lines). TA: Enamel. A: Principal U.K. Ports and Abroad. Ship's Compositions and Paint Manufacturers, and Painting Contractors. (See Advert.).

Wells (Matthew) & Co. Ltd., "Wellsaline" Oil Works, Bolton Street, Manchester, 3. D: V. H. Stott (Managing), H. Rothbarth (Ch.), A. B. Balmford, R. S. Bickerton.

NETHERLANDS

Frenk (N. S.) & Son, "Atlantic House," Westplein 2, Rotterdam. Ship Chandlers and Bonded-Store Dealers.

Van Der Toorn's Import and Export-Handel, Treilerweg 74-76, Scheveningen. P: C. van der Toorn, C.Z.N. Proofing Materials for Fishing Nets, etc.

NEWFOUNDLAND

Newfoundland Shipyards Ltd., Clarenville, Newfoundland D: H. D. Macgillivray, J. L. Grieve, C. P. Diamond. B. Fearn, S. G. Lake. Shipbuilders and Repairers.

NORWAY

BERGENS MEKANISKE VERKSTEDER, Bergen. TA: Verkstedet. Ship Builders, Repairers and Engine Makers. (See advert).

SOUTH AFRICA

Hackner (Sam) & Co. (Pty.) Ltd., 130/2, Commercial Road, Durban, Natal, S.A. D: Sam Hackner. Rachel Hackner, Julius Gurwitz, R. Polakow, A. Goldberg. Twines and Cordage.

UNITED STATES OF AMERICA

Advice Incorporated, 1757 N. Street N.W., Washington 6, D.C. T: Adams 2311. TA: "Advice." Pres.: Harry Cooper. Vice-Pres.: Walter E. Reid. General fishing equipment, fishing boats, trawlers, etc.

The Aquacide Company, 53, Commercial Wharf, Boston 10, Mass. D: L. T. Hopkinson, H. E. Crowther, R. H. Flowers. Liver preservatives, general deodorants.

Atlas Mineral Products Co. of Penna, Mertztown 20, Pennsylvania. D: George L. Wirtz (Pres.), C. R. Payne (Vice-Pres. and Tech. Dir.) A: Tanks & Linings, Ltd., 14, Foregate, Worcester, Eng. Floors, Acid- and Alkali-Proof; Cements, Acid- and Alkali-Proof.

Bath Iron Works Corporation, 700, Washington Street, Bath, Maine. D: William S. Newell, Archibald M. Main, Wadleigh B. Drummond, G. Baer Connard, J. William Schulze, Andrew B. Sides, J. Kenneth Hall, John R. Newell. Shipbuilders.

Chemical and Process Machinery Corp., 146, Grand Street, Corner Lafayette St., New York, 13. Dealers in new and rebuilt equipment for fishing vessels.

Detjen Corp., 303, West 42nd Street, New York 18. TA: Detjencorp. Manufacturers of Electric fly screens, and of Electric insect killing devices for canneries and fish processing plants.

Electric Fly Screen Co. Inc., 669, Eighth Avenue, New York, 16. Insect Electrocutors, fly screens and electric fly traps.

FISH NET & TWINE COMPANY (THE), 310-312, Bergen Avenue, Jersey City 5, New Jersey. (See advert.).

Hager (R. B.), 118, West 57th Street, New York, 19. TA: Arbhager. Export Sales Agent for Coal and Coke, foreign bunkers.

Linen Thread Co. Inc., 60, East 42nd Street, New York, 17. Nets and Cordage.

The Radelma Company, 53, Park Place, New York 7, N.Y., U.S.A. P: Harry Adelman. A: Scenic Radio & Electronics Co., 53, Park Place, New York 7, N.Y. Exporters of Marine Transmitters, Receivers, Radio Parts.

Submarine Signal Company 160, State Street, Boston, Mass. B: Submarine Signal Ltd. (England), Artillery House, Artillery Row, London, S.W.1.

Undine Twine Mills, Moodus, Conn., Seine. Twine, sail twine, etc.

Thiel (Philip) Jr., Ipswich Mass. Naval Architect and Marine Engineer.

Ullmann-Allied Commodities Corp., 131, West 30th Street, New York 1. Coagulants for fish proteins, and Preservatives for fish livers.

VII FISH BY-PRODUCTS

Meal, Oil, Vitamins, Etc.

ARGENTINA

Laboratorios Washington S.A., 25 de Mayo 267, Buenos Aires. D: Townsend Moore, Jean I. Campbell. A: Townsend Moore & Co., Seattle, Wash. U.S.A. Producers of Vitamin Oils.

CANADA

STANDARD FISH COMPANY, 5181, St. Lawrence Blvd., Montreal. (See advert.).

DENMARK

Bornholms Fiskemelsfabrik I/S., Pr. Osterlars. Hovedkontor: Overgaden o. Vandet 44, K.

Bornholms Levertranfabrik A/S., Snogebæk pr. Nexo. Hovedkontor: Rysensteensgade 6, V.

Fiskemollen A/S., Kerteminde.

Fiskemelsfabriken "Nordjylland" A/S., Skagen.

Hirtshals Fiske-Hermetik A/S., Hirthslas. Hovedkontor: Badstuestræde 13, K.

Kobenhavns Fiskemelsfabrik, Oliefabrikvej 215, Kastrup.

Lettebaek Fabriker, Fruens Boge.

Naestved Fiskemelsfabrik, Naestved.

Skagens Fiskemelsfabrik v/Hugo Warburg, Skagen.

GREAT BRITAIN

The Caledonian Milling Company (Aberdeen) Ltd., Palmerston Road, Aberdeen. MD: William Mellis.

Grimsby Fish Meal Co. Ltd., Pyewipe, Grimsby, Lincs. T: 5041. TA: Fishmeal.

Herring By-Products Limited, 32, Schoolhill, Aberdeen. D: S. Bartz-Johannessen, Chr. Bartz-Johannessen, C. A. McLachlan, G. W. Reid. Factories: West Shore, Fraserburgh, and Heogan Factory, Bressay, Shetland. Herring Meal and Herring Oil Manufacturers.

Hull Fish Meal & Oil Co. Ltd., St. Andrew's Dock, Hull. T: Central 37780. TA: Fishmealco. D: S. Nowell (Ch.), W. H. Ashton (V.Ch.), L. A. Walton, J. E. Tether, G. A. Cawood, G. Hudson, A. Cargill, H. Wight, W. A. Crockford Jnr., R. Willey, T. W. Boyd Jnr. Animal Feeding stuffs, including fish meals, fertilisers, fish oils, liquid fish glues and process engraving glue.

Meade-King, Robinson & Co. Ltd., 501, Tower Building, Water Street, Liverpool 3. D: William Smellie, A. J. D. Smellie, Arthur Robinson, F. A. Robinson, E. N. Robinson. A: London, Birmingham, Leeds, Manchester, Glasgow, New York, Rotterdam.

Mutual Fish Products Co. Ltd., Albert Quay, Aberdeen. D: Robert Milne (Ch), John Craig, Alex. Freeland, John Spencer, J. M. Davidson, J. F. Robertson, T. D. Smith, John Collins, C.A. (Gen. Manager).

Normansell (Henry), (Fish Meal Dept.), St. John's Lane, Dudley Port, Staffs. T: Midland 4500 (Enquiries); Tipton 1312 (Factory). TA: Normansell. P: Frederick Henry Normansell, J.P.

The North Shields Fish Guano & Oil Company Limited, Low Lights, North Shields, Northumberland.

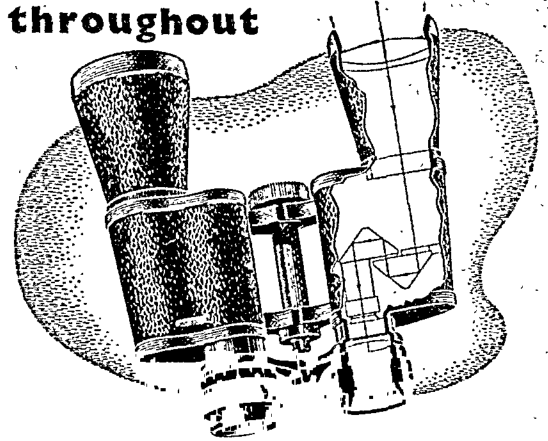
Salvesen (Chr.) & Co., 29, Bernard Street, Leith. P: D. H. K. Salvesen, I. R. S. Salvesen, T. H. Humphreys, R. C. Geddes, C. G. Marshall, L. M. Harpergow. Branch: 94, Hope Street, Glasgow, C2. Manufacturers of Whale Oil and By-Products of Whales.

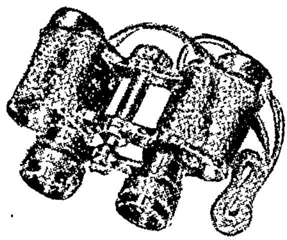
The White Fish Meal Co. (Gildersome) Ltd., Gelderd Road, Gildersome, nr. Leeds. D: Mr. Herbert Hobbs and Miss E. C. Hobbs.

ICELAND

ICELANDIC STATE HERRINGOIL & MEAL FACTORIES, Siglufjordur. **D: Sveinn Benediktsson, Erlendur Thorsteinsson, Jon Kjartansson, Julius Havsteen, Poreddur Gudmundsson. M: Sigurdur Jonsson.**

Precision made throughout for life-long satisfaction





The "Olympic" (8 x 30) Price £26 . 10 . 0 including leather case, sling and purchase tax.

KERSHAW

Kershaw Soho (Sales) Ltd., 37/41 Mortimer Street, London, W.1.

▲ All lenses and prisms in the optical system have 'Bloomed' surfaces to give maximum brilliance.

▲ All optics are made in the Kershaw factory, and angles of deviation conform to highest War Office specifications.

▲ Perfect balance allows sturdy construction to be combined with feather-light handling.

▲ All materials and workmanship are under rigid inspection at every stage of manufacture.

K.B.4

The FISH NET and TWINE Co.

Steel Grey Linen Gill Netting
(Reg. U.S. Patent)
Genuine Sea Island Cotton Gill Netting
Superior Quality Cotton Gill Netting
Cotton Seine and Pound Netting

★

310 Bergen Avenue, Jersey City, N.J., U.S.A.
Cable Address: "FISHNET"

Lysi Limited, P.O. Box 625, Reykjavik. MD: Tryggvi Olafsson.

INDIA

Khailan Sons & Co., 1, Commercial Bldg., Clive Street, Calcutta. Fish Oil Manufacturers.

West Coast Fisheries (Travancore) Ltd., Main Road, Trivandrum, Travancore.

NEWFOUNDLAND

Nfld Dehydrating Process Co. Ltd., Corner Brook. Other Plants at St. John's and Belleoram. Head Office: St. John's. MD: C. A. Crosbie. B: Dehy. Process Co., Boston, Mass.

NORWAY

Gjert (J. Lie), A/S., Bergen. Speciality: Cod Liver Oil.

UNITED STATES

Eastern Marine Products Co., 53, Commercial Wharf, Boston 10, Mass. Manufacturers representatives for medicinal cod liver oil, fish oils and meal.

Fromm (F. H.), Co. Inc., 100, Warren Street, New York 7. Since 1902 spec. in Fishery Products.

Halibut Liver Oil Producers, 15th Ave. N.W., Seattle 7, Washington. Office and Manager: 790, Broad Street, Newark, N.J.

Marine Products Co., 345, West First St., Boston 27, Mass. P: Edward J. Iorio.

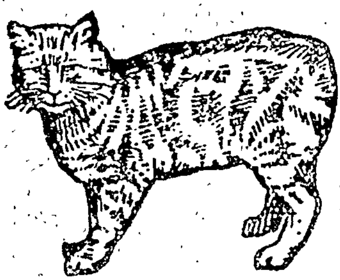
Scandinavian Oil Co., 104, Front Street, New York 5. TA: Transcand File. Medicinal, veterinary cod liver oil, and industrial fish oils.

Szenkovits (G.C.), Chrysler Bldg., New York, 17. TA: Ezenkovits. Also at Toronto and Montreal. Fish, fish liver oil and meal. Also exporters of canned, processed and fresh fish.

Townsend Moore & Co., 2016, Smith Tower, Seattle, 2, Wn. Producers of vitamins A derived from fish livers with plants in Argentina.

WORLD FAMOUS

RUMPY BRAND MANX KIPPERS



REGISTERED TRADE MARK

No dyes or chemicals used in processing

•

Season :
June—September (inclusive)

SOMETHING QUITE DIFFERENT IN KIPPERS

ENQUIRIES WAITED :

A. D. McEVOY, LTD.

STANLEY ROAD, PEEL, ISLE OF MAN (Gt. Britain)

"GAMECOCK"

BRAND

Kippers and Smoked Fish

JOHN KELSALL & SONS, LTD.

108, HIGH STREET, MANCHESTER, 4

Telegrams: "GAMECOCK" *Telephone*: DEANSGATE 4236

Branches : FRASERBURGH, GT. YARMOUTH, LIVERPOOL
GRIMSBY and NORTH SHIELDS

Smoke Houses : Fraserburgh, Gt. Yarmouth, Grimsby, North Shields

VIII -- List of Trade Marks and Names

Name	Description	Producers or Distributors
	A	
Acme	Fish frying equipment	Acme Engineering Co., Ltd., Stocks Hill, Leeds, 11.
AE	Processed fish ..	A. Espersen, A/S, Ronne, Denmark.
A.F.I.	Canned and preserved fish	Australian Fishing Industries, Ltd., North Sidney, N.S.W.
Arms of Scheveningen	Canned and preserved fish	Van Der Toorn's Im. En Exporthandel, Scheveningen
Atlantic ..	Shellfish	Brian Ogilvie, Killorglin, Co. Kerry, Eire.
	B	
B (in diamond)	Fresh, processed and canned fish . .	Brekkes Limited, Hull.
Balco Brand ..	Canned fish, etc. ..	Bering Sea Codfish Co., 123, Jackson Street, San Francisco, U.S.A.
Bar Harbour Brand ..	Canned and preserved fish	North Atlantic Packing Co., 80, Federal Street, Room, 504. Boston, Mass, U.S.A.
Barnacle Bill ..	Preserved fish ..	Bluewater Fisheries Ltd., Saint John, Canada.
Bass	Canned and preserved fish	W. E. Fuller (Pty.) Ltd., 390, Little Collins Street, Melbourne, Australia.
Bass	Canned and preserved fish	Fuller (W. E.) & Co. Ltd., Wellington, C.1, New Zealand
Besco	Can making machinery	Edwards (F. J.). Ltd., 359/361, Euston Road, London, N.W.1.
Biloxi Brand ..	Canned fish	Biloxi Canning & Packing Co., P.O. Box 177, Biloxi. Miss., U.S.A.
Biloxi Miss ..	Canned fish	Biloxi Canning & Packing Co., P.O. Box 177, Biloxi. Miss.
Binder's ..	Canned fish . .	U.S. Conserve Company, St. Louis 20, Miss., U.S A.
Blue Gold ..	Cured, processed and canned fish ..	Pecheurs Unis de Quebec, 6381 St Lawrence Blvd., Montreal, Canada.
Blue Star .	Canned fish ..	U.S. Conserve Company, St. Louis 20, Miss., U.S.A.
Bluewater ..	Cured, canned and preserved fish .	Bluewater Fisheries Ltd., Saint John, Canada.
	C	
Calda Cutch ..	Supplies for fisheries	Forestal Land, Timber & Railways Co., Ltd., London, E C 4.
C.A.N.E. Brand	Canned and preserved fish	Garcia (Rogelio), San Sebastian, Spain.
Cantabro Brand	Canned and preserved fish	Cantabro Mediterranean S.A., P.O. Box 203, Tetuan.

Name	Description	Producers or Distributors
Chernikeeff Log	Supplies for fisheries	Improved Submerged Log Co., Ltd., London, S.W.1.
Coastal Brand .	Canned and preserved fish	Coastal Canneries, Ltd., 1. Hamilton Road, Lowestoft.
Confidence Brand ..	Frozen fish	J. Amos & Son, Fish Docks, Grimsby.
Corvette ..	Cured, processed and canned fish	Pecheurs Unis de Quebec, Montreal, Canada.
Cream of Cod	Preserved fish products	Rheaume (H.) & Sons, Ltd. Montreal, Qu.
Crown	Cured, canned and preserved fish ..	Bluewater Fisheries Ltd., Saint John, Canada.
	D	
D & D .. .. **(in square)** ..	Fresh, processed and canned fish	Dishman & Degnan Limited, St. Andrews Dock, Hull.
Dalco	Fresh, processed and canned fish	Dalton-Cooper, Inc., 200, West 34th Street. New York, 1, N.Y.
	E	
El Sol	Cured fish (codfish) ..	Erik Rolfsen a/s., Kristiansund N., Norway.
	F	
Finsita	Canned and preserved fish	Maine Sardine Packers Export Association, New York City 4.
Fish-Fry ..	Canned fish	U.S. Conserve Company, St. Louis 20, Miss., U.S.A.
F.F.F.	Fresh and frozen fish	Fresh Frozen Foods Ltd., London.
Foie de Gaspe .	Preserved fish products	Rheaume (H.) & Sons, Ltd. Montreal, Qu.
Frigmobile ..	Cold storage and transport of fish ..	Morrisons Engineering, Ltd., London, W.1.
Fuller's ..	Canned and preserved fish	Fuller (W. E.) & Co. Ltd., Wellington, C.1., New Zealand.
Fuller's ..	Canned and preserved fish	W. E. Fuller (Pty.) Ltd., Melbourne, Australia.
	G	
Globe	Cured, fresh, canned and preserved fish	Globe Fish Packing Factory, P.O. Box 31, Zomerstraat, 51, Vlaardingen, Holland.
Gloria	Canned and preserved fish	Wax & Vitale, Genoa, Italy.
GTS Brand of Excellence ..	Cured fish	Tether (Geo.) & Sons, Ltd., West Dock Street, Hull.
	H	
Highland Lassie	Cured kippers ..	R. & C. W. Dawson, Seahouses, Northumberland.
	I	
Ishmel	White fish meal ..	The White Fish Meal Co. (Gildersome) Ltd.

Name	Description	Producers or Distributors
J		
Jalco	Cured fish	Larsen, I.A. & Co., Frederikshavn, Denmark.
JCS Brand	Fresh and cured fish	Sudders (J. C.) (Lowestoft), Ltd., Lowestoft.
Jenny	Canned and preserved fish	Co-operative Wholesale Society Ltd., Waverny Drive, Lowestoft.
JMP	Cured fish	More (James), Ltd., Miller Street, Wick.
L		
La Couronne	Cured and canned fish	Saurisserie La Couronne S.A., Ostende, Belgium.
Lifebelt Brand	Cured fish	Gallagher Bros., Main Street, Killybegs, Co. Donegal.
Lindo	Processed and canned fish	J. G. Lindenberg, Schiedam, Holland.
M		
Mainesail Brand	Canned and preserved fish	North Atlantic Packing Co., 80, Federal Street, Room 504, Boston, Mass., U.S.A.
Marela	Pickled and preserved fish	Marela Limited London.
Marelli	Dried codfish	Miller, (F. A.), Ltd., 27/28, Dock Street, Leith, Edinburgh, 6.
Mavar	Canned Shrimps and Oysters	Mavar Shrimp & Oyster Co. Ltd., P.O. Box 66, Biloxi, Miss., U.S.A.
Mervitee	Kippers	Alec Green, Hull.
Morton	Cured, canned and preserved fish	Morton (C. & E.) Ltd., London, E.C.3.
Moscovy	Canned fish	U.S. Conserve Company, St. Louis 20, Miss., U.S.A.
N		
Nordel Brand	Fresh, cured, processed and canned fish	Northern Delicacies, Ltd., Manchester 8.
Norsea	White fishmeal	Caledonian Milling Co. (Aberdeen) Ltd., Aberdeen.
North Atlantic Brands	Fish meal	Marine Products Co., Boston 27, Mass., U.S.A.
O		
Ocean Swell Brand	Frozen fish	J. Amos & Son, Fish Docks, Grimsby.
Olivia	Canned Shrimps and Oysters	Mavar Shrimp & Oyster Co. Ltd., P.O. Box 66, Biloxi, Miss., U.S.A.
P		
Palace Brand	Manx kippers	Geo. Rodgers & Son, Ltd., Mill Road, Peel, Isle of Man.
Papa Falcone	Canned fish	Societe Falcone, Pierre Aine et Fils, Nemours, Algeria.
Pilot Brand	Cured fish	J. Clayburn & Co., Ltd., Grimsby Docks.
Pirate	Cured, canned and preserved fish	Bluewater Fisheries Ltd., Saint John, Canada.

Name	Description	Producers or Distributors
Predilecto ..	Saltfish and canned fish	Hawes & Company (London) Ltd., London.
Prestcold ..	Refrigeration machinery and equipment	Pressed Steel Co., Ltd., Oxford.

Q

Quality Fish ..	Cured fish	Jensen (Tarben P.), I/S., Esbjerg, Denmark.
Quality-Plus Line ..	Fresh, processed and canned fish	The Tillham Corporation, 123/133, William Street, New York 7, N.Y.

R

Red-E-Serv ..	Canned fish	U.S. Conserve Company, St. Louis 20, Miss., U.S.A.
Redflake ..		Sidwell & Co. Ltd., London.
Redfunnel ..	Cured fish	Red Funnel Trawlers Pty., Ltd., No. 5 Wharf, Woolloomooloo, Sydney, N.S.W.
Redifon ..	Radio communication and industrial heating equipment ..	Rediffusion, Ltd., London, S.W.18.
Red Leaf ..	Processed and canned fish	McQueen, White & Dickinson Co. Ltd., 1030, Hamilton St., Vancouver, Canada.
Red Lily Brand	Cured fish	Burton (William J.), Ltd., Great Yarmouth.
Rumpy	Kippers	McEvoy, Isle-of-Man.

S

Saldanha Brand	Canned and preserved fish	Saldanha Bay Canning Co. Ltd., Cape Town, S. Africa.
Salty Sam ..	Cured, canned and *preserved fish* ..	Bluewater Fisheries Ltd., *Saint John, Canada.*
Samecock ..	Kippers and smoked fish	Kelsall (John) & Sons, Ltd., Manchester.
Seafoods ..	Cured and processed fish	Markham Cook (H.) Ltd., Grimsby.
Sea Haul Brand	Canned fish	K. J. Preiswerck Ltd., Vancouver, Canada.
Seahaven Brand	Canned and preserved *fish*	Ocean Canning Co., Fremantle, W. Australia.
Seahouses ..	Processed and canned fish	G. Archbold & Sons, Seahouses, Northumberland.
Sea Maid ..	Canned Shrimps and Oysters	Mavar Shrimp & Oyster Co.
Silvercrest ..	Canned Shrimps and Oysters	Mavar Shrimp & Oyster Co.
Silver Sea ..	Canned fish	Fish Canneries of Tasmania Pty., Launceston, Tasmania.
Skarsten ..	Machinery and equipment	Skarsten Manufacturing Co. Ltd., 1, Hyde Way, Welwyn Garden City.
Solan Brand ..	*Preserved fish products*	Rheaume (H.) & Sons, Ltd. Montreal, Qu.
Solmar	Saltfish and canned fish	Hawes & Company (London) Ltd., London.
Spanish Main .	Cured, canned and preserved fish	Bluewater Fisheries Ltd., Saint John C[illegible]

Name	Description	Producers or Distributors
S.P.P.	Cured fish	Petersens (S. P.), Eftf., Fuglefjord, Faroe Islands.
Spiga	Canned and preserved fish	Wax & Vitale, Genoa, Italy.
S. & R. Glasgow	Fresh fish	Smith & Ritchie (Fisheries) Ltd., Glasgow.
Success	Cured fish	Field (Jeff) Ltd., Hull.
	T	
Tanfiscan ..	Canned fish	Fish Canneries of Tasmania Pty. Ltd., 54, Launceston, Tasmania.
Turbot	Cured fish	George Lauder & Coy. (Aberdeen) Ltd., Aberdeen, Scotland.
	U	
Ulco	Feeding stuffs	Hull Fish Meal & Oil Co., St. Andrew's Dock, Hull.
Unity	Canned fish	Co - operative Wholesale Society Ltd., Lowestoft.
	V	
V & Shamrock	Cured fish	Devane (Patrick), Dingle, Co. Kerry, Eire.
Vascello ..	Canned fish	Pontecorboli (Mario di Giacomo), Via Gramsci 3/8, Genoa, Italy.
Victor	Canned Shrimps and Oysters	Mavar Shrimp & Oyster Co. Ltd., P.O. Box 66, Biloxi, Miss., U.S.A.
Victory Brand .	Cured and processed fish	Kwakkelstein (W.), Westhavenkade 65-69, Vlaardingen.
Viking	Fish meal	Marine Products Co., 345, West First St., Boston 27, Mass., U.S.A.
Viking Brand ..	Fresh, processed and canned fish .. .	Standard Fish Company, 5181 St. Lawrence Boulevard, Montreal, Canada.
Vita Brand ..	Cured and canned fish	Vita Food Products, Inc., 644/654, Greenwich Street, New York 14.
	W	
Wapen Visser .	Cured, processed and canned fish . ..	Koen Visser N.V., Paling-en Zalmrokerij. Oud - Beijerland Holland.
Windsor Red Atlas ..	Fresh processed and canned fish . ..	Brussaad's Handelmaatschappy N.V., 15, Vredenoordkade, Rotterdam.
Wylax	Canned fish	Wylax Canning Co., Woudrichem, Holland.
	Z	
Zelax	Canned fish . ..	Wylax Canning Co., Woudrichem, Holland.

IX - - - Buyers Guide and Classified List of Advertisers

ANCHOVIES

FRANCE

Etabl. Falcone Pierre Aine & Fils, Nemours.

ITALY

Mario Pontecorboli di Giacomo, Genoa.

AUCTIONEERS (Fish)

GREAT BRITAIN

Geo. B. Bee, Ltd., Grimsby.

BANKS

ICELAND

Landsbanki Islands (The National Bank of Iceland, Reykjavik.

BOBBINS (Trawler)

GREAT BRITAIN

Charles Benn & Sons, Stourton, Leeds, 10.

BLOATERS

(See under Kippers).

BINOCULARS

GREAT BRITAIN

Kershaw-Soho (Sales), Ltd., London, W. 11.

BOOTS (Rubber)

GREAT BRITAIN

Repairers: Timpsons, London Road, North Lowestoft, also at Leith, Aberdeen, Fleetwood and Hull.

BOXES AND CASES for Fish Packing

GREAT BRITAIN

Aviation Development, Ltd., London, W.C.1.

Hull Merchants Amalg. Boxes, Ltd., Hull.

Morrison Engin., Ltd., Rochester, Kent.

West Dock Timber Co., (Aluminium Boxes) Hull, England.

BREAM

NETHERLANDS

Wijnbelt & Co., Woudrichem.

POLAND

Centrala Rybna, Ltd., Warszawa.

BUCKLING

GREAT BRITAIN

Pommer & Thompson, Ltd., Great Yarmouth.

NETHERLANDS

Van der Windt's Handel Mij., Vlaardingen.

CANNING MACHINERY

F. J. Edwards, Ltd., London, N.W.1.

CANNED FISH

(see Section III).

CANVAS

GREAT BRITAIN

Henry Jordan & Son, 17, Salthouse Lane, Hull, England.

CASES AND BOXES for Fish Packing

GREAT BRITAIN

Aviation Development Co., Ltd.

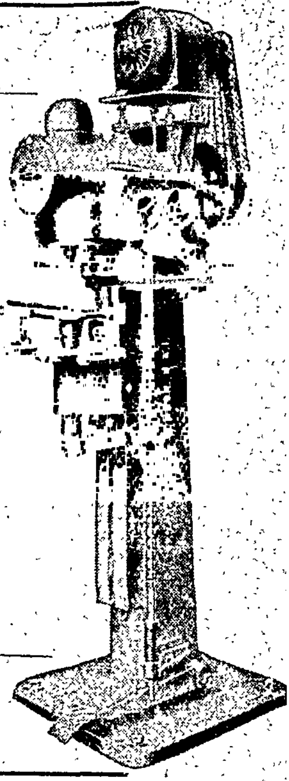
West Dock Timber Co., Ltd., Hull England.

Can Making Machinery

The illustration shows the new "Besco" No. 12 double seaming machine. Semi-automatic, its capacity is from $1\frac{1}{2}$in. to $6\frac{1}{2}$in. diameter and from $\frac{3}{4}$in. to 17in. high.

We are specialists in used machines of all types and can offer to all interested inquirers, a comprehensive range covering all the applications of can making. We have over 500 used machines in stock including round and irregular seamers for flat or tall cans with automatic or hand feed, flangers, soldering machines, etc.

KNOWN THE WORLD OVER
BESCO MACHINERY
REGISTERED TRADE MARK



F. J. EDWARDS LIMITED

359 - 61, *EUSTON ROAD,*
LONDON, N.W.1., ENGLAND

Telephones: EUSton 4681 & 3771 *Cables: Bescotools, London*

Are YOU interested in

Canned Fruit?

If so, you will find a list of fruit canners and distributors of canned fruit in the only World Directory and Year-Book of this trade, the

FRUIT ANNUAL AND DIRECTORY

Published by:—
BRITISH-CONTINENTAL TRADE PRESS, LTD.,
222, STRAND, LONDON, W.C.2.

Price £1, post free.

CLEANSER (CHEMICAL)
Shell Chemicals, Ltd., London.

COD (Dried)
UNITED STATES
Bering Sea Codfish Co., 123 Jackson Street, San Francisco.

COD (Salted)
CANADA
Snow Fisheries, Ltd., Royal Bank Bldgs., Montreal.
DENMARK
A. Espersen, Ronne Bornholm.
Laur. Ronn, A/S, Esbjerg.
GREAT BRITAIN
Thomas Ross, Ltd., Grimsby.
Rinovia Steam Fishing Co., Ltd., Grimsby.
Smethurst (Fish Curers), Ltd., Grimsby.
ICELAND
Union of Icelandic Fish Producers, Reykjavik.
NEWFOUNDLAND
George T. Dixon, Ltd., Fortune, Burin District.

CORK
GREAT BRITAIN
British Cork Mills, Ltd., 167, Victoria St., London.

CRAYFISH
POLAND
Centrala Rybna, Ltd., Warszawa.

DRIVES for Winches, Capstans, etc.
GREAT BRITAIN
Vickers - Armstrongs, Ltd., London, S.W.1.

EEL
NETHERLANDS
Wijnbelt & Co., Woudrichem, Holland.
POLAND
Centrala Rybna Ltd., Warszawa.

ENGINES (Marine Diesel)
DENMARK
Burmeister & Wain, Copenhagen.
GREAT BRITAIN
Caledonian Fishselling & Marine Stores, Co., Ltd., Peterhead.
Vickers - Armstrong, Ltd., London, S.W.1.

FILLETS
CANADA
Snow Fisheries, Ltd., Royal Bank Bldg., Montreal.
GREAT BRITAIN
Smethursts (Fish Curers), Ltd., Grimsby.
Thomas Ross, Ltd., Grimsby.
Geo. Tether & Sons, Ltd., West Dock Street, Hull.

FLOATS
GREAT BRITAIN
British Cork Mills, Ltd., 167, Victoria St., London.
Philipp's Trawl Products, Ltd., Grimsby.
Middleton, R. L., Fish Docks, Grimsby.

FREEZING PLANT
J. & E. Hall, Ltd., Dartford, Kent, England.
John L. Rogers & Staff, Abbey House, London, S.W.1.

GEAR (Fishing)

(See also Section VI "Supplies for Fisheries").

GREAT BRITAIN

Caledonian Fishselling & Marine Stores, Co., Ltd., Peterhead, etc.

Great Grimsby Coal, Salt & Tanning, Co., Ltd.

GUT (Fishing)

AUSTRALIA

Union Gut Co., Pty., Ltd., Mornington, Victoria.

GUTTING MACHINES (for Herrings)

GREAT BRITAIN

Arenco Ltd., 4, Carlisle Avenue, London, E.C.3.

HERRING (Fresh)

EIRE

Gallagher Bros., Killybegs, Co. Donegal.

GREAT BRITAIN

Associated Herring Merchants, Ltd., Aberdeen.

Bloomfield's Ltd., Great Yarmouth.

Smith & Ritchie (Fisheries), Ltd., Glasgow, C.1.

Geo. Tether & Sons, Ltd., Hull.

NETHERLANDS

B.den Dulk, Katwijk a.z.

NORWAY

Statens Kjoeleanlegg og Fryseri, Aalesund.

HERRINGS (Salted, Smoked, etc.)

CANADA

Snow Fisheries, Ltd., Montreal.

DENMARK

J. F. Kjolbro, Klakksvik, Faroe Islands.

EIRE

Gallagher Bros., Killybegs, Co. Donegal

GREAT BRITAIN

Associated Herring Merchants, Ltd., Aberdeen.

Bloomfield's Ltd., Great Yarmouth.

Henry Sutton, Great Yarmouth.

NETHERLANDS

B.den Dulk, Katwijk a.z.

Van der Windt's Handel Mij., Vlaardingen.

H. Van Wingerden & Zoon, Scheveningen.

NORWAY

Statens Kjoeleanlegg og Fryseri, Aalesund.

KIPPERS

EIRE

Gallagher Bros., Killybegs, Co. Donegal.

GREAT BRITAIN

Associated Herring Merchants, Ltd., Aberdeen.

Bloomfield's Ltd., Great Yarmouth.

Robert Chapman, Ltd., Grimsby.

The Ross Group Grimsby.

Henry Sutton, Charles St., Great Yarmouth.

Geo. Tether & Sons, Ltd., Hull.

ISLE OF MAN

A. D. McEvoy, Ltd., Peel.

T. Moore & Sons, Peel.

LIFE-SAVING EQUIPMENT

GREAT BRITAIN

Schermuly Pistol Rocket Apparatus, Ltd., Newdigate, Surrey, England.

LOBSTERS

EIRE

Gallagher Bros., Killybegs, Co. Donegal.

HOLLAND

H. Van Wingerden & Zoon, Scheveningen.

LOGS, ELECTRIC

GREAT BRITAIN

Thos. Walger & Son, Ltd., 58, Oxford Street, Birmingham.

MACKEREL (Salted)

HOLLAND

B. Den Dulk, P.O.B.8., Katwijk a.z., Holland.

MATJES HERRINGS

HOLLAND

B. Den Dulk, P.O.B.8., Katwijk a.z., Holland.

H. Van Wingerden & Zoon, Scheveningen.

MEAL (FISH) MANUF. PLANT

Alfa-Laval Co., Ltd., Brentford, Middlesex, England.

The Farrar Boilerworks, Ltd., Newark, England.

NETS

GREAT BRITAIN

Joseph Gundry & Co., Ltd., Bridport.

R. L. Middleton, Ltd., Fish Docks, Grimsby.

UNITED STATES

Fish Net and Twine Co., Jersey City, N.J.

OIL (FISH) EXTRACTION PLANT

Alfa-Laval Co., Ltd., Brentford, Middlesex, England.

The Farrar Boilerworks, Ltd., Newark, England.

OIL (Herring)

ICELAND

Sildarverksmidjur Rikisins (Icelandic State Herring Oil & Meal Factories), Siglufjordur.

OIL (for Ships)

GREAT BRITAIN

Caledonian Fishselling & Marine Stores Co., Ltd., Peterhead, etc.

OYSTERS

U.S.A.

Mavar Shrimp & Oyster Co., Ltd., Biloxi, Miss. (Canned).

PACKING MATERIALS

See Section V.

PAINT

GREAT BRITAIN

Greyhound Paint & Composition Co., Ltd., London, W.C.2.

International Paint & Compositions, Ltd., London.

Websters, Ltd., Hull.

PERCH

NETHERLANDS

Wijnbelt & Co., Woudrichem.

POLAND

Centrala Rybna, Ltd., Warszawa.

PIKE

NETHERLANDS

Wijnbelt & Co., Woudrichem.

POLAND

Centrala Rybna, Ltd., Warszawa.

PILCHARDS

UNITED STATES.

Balestrieri & Co., 123, Jackson Street, San Francisco, Cal.

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ADVERTISERS' INDEX (*Continued*).

The optical analog of the Shubnikov-de Haas effect has been observed in the semi-metal antimony by DRESSELHAUS and MAVROIDES[1] and the results, observed in reflection, are shown in Fig. 23. Anisotropy and mass parameters were obtained.

Another possibility, distinct from the above, is the use of high field experiments in which the cyclotron resonance frequency is swept through the frequency of the optical modes of lattice vibrations. In the case of polar crystals interaction with optical modes can cause "polaron" effects in the effective mass and also enhanced scattering influencing the relaxation time τ. Faraday rotation and ellipticity may be used as "remote" measuring techniques for m^* and τ to observe the effect of tuning the cyclotron and lattice resonances by observing at higher frequencies. Such effects have bein observed at Reading in PbTe[2].

All the free carrier effects have been discussed as appropriate to infra-red rather than microwave frequencies. This implies that measuring frequencies $\omega \gg 1/\tau$ the relaxation time. Quite different information is obtained in the low frequency region where this condition no longer holds and all effects are strongly dependent upon τ and hence require a full treatment of scattering mechanism. In this review, therefore, we have restricted the discussion to the cases where band structure information can be inferred, i.e., where the dependence upon τ is weak, without detailed theory of scattering process. It is the possibility of such separation that gives the infra-red methods their particular importance.

V. Interband effects.

20. Introduction. The transitions between valence states and conduction states which are responsible for interband effects were discussed in Part III and the energy for non-degenerate parabolic bands with spherical energy surfaces are given in Eqs. (9.12) and (9.13). Transitions of this type are responsible for a variety of resonant or oscillatory phenomena such as interband magnetoabsorption (IMO) which may be considered the primary phenomenon, and derived effects such as resonant Faraday and Voigt effects and interband magneto-reflection. These effects occur at photon energies greater than the minimum energy gap between conduction and valence bands. At lower photon energies there are non-resonant effects, particularly Faraday and Voigt effects caused by the summed effects of all the allowed interband transitions. As mentioned in the introduction the resonant effects have been observed only since 1956 whereas interband Faraday effect, for example, has a long history. It will however be convenient to treat the resonant phenomena first as the origin of the nonresonant effects then becomes apparent on application of the Kramers-Kronig relations given in Part II, Sect. 13 to the interband transitions.

Progress in this field up to 1959 has been reviewed by LAX and ZWERDLING (1960)[3].

21. Direct transitions — interband magneto-absorption. In the absence of a magnetic field the dominant interband absorption process is the direct, or vertical, transition in which the initial and final states have the same $\boldsymbol{k}$ vector. The absorption coefficient is then obtained by summing the squares of the matrix elements over all states arising from valence and conduction bands and is given by

$$\alpha(\omega) = A \int d^3k \, |\boldsymbol{\alpha}\cdot\boldsymbol{p}_{cv}(\boldsymbol{k})|^2 \, \delta\left[E_c(k) - E_v(k) - \hbar\,\omega\right] \tag{21.1}$$

[1] See B. LAX: Proc. Int. Conf. on Physics of Semiconductors, Paris, 1964, p. 262.
[2] See Sect. 21 for similar effects in IMO.
[3] B. LAX, and S. ZWERDLING: Progr. in Semiconductors 5, 221 (1960).

where

$$A = \frac{\pi e^2}{n m^2 c \omega \varepsilon_0} \frac{2}{(2\pi)^3}$$

α is a polarisation vector and p_{cv} was defined in Eq. (10.3) substituting c, v for α, γ. The integration over the states defined in the δ-function introduces the density of combined conduction and valence states. For spherical surfaces and parabolic bands this varies as $(\hbar\omega - E_G)^{\frac{1}{2}}$ and for *allowed* transitions where p_{cv} is non zero at $k=0$ the absorption coefficient is

$$\alpha(\omega) = A'(\hbar\omega - E_G)^{\frac{1}{2}} \tag{21.2}$$

where

$$A' = \frac{e^2}{2\pi n m^2 c \omega c \varepsilon_0} \left(\frac{2m^*}{\hbar^2}\right)^{\frac{3}{2}} |\alpha \cdot p_{cv}(k)|^2$$

and

$$m^* = m_c m_v / (m_c + m_v) \tag{21.3}$$

is the *reduced* effective mass.

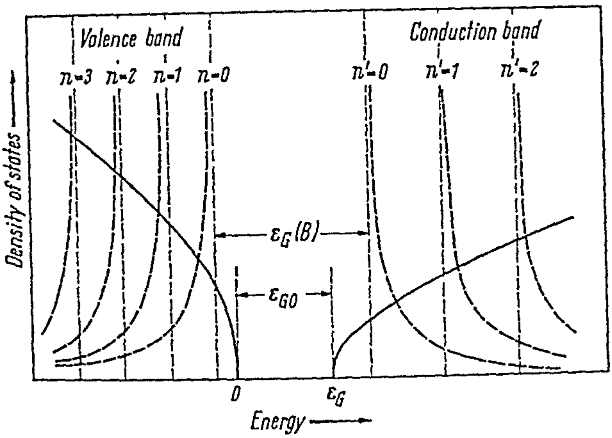

Fig. 24. Density of states at Landau levels (dotted) and the absence of a magnetic field (full line) for simple bands (after BURSTEIN et al., Ref. 4, p. 257).

In the corresponding magnetic case, the density of states changes drastically due to the high degeneracy of the Landau levels as discussed in Part III, Eqs. (9.9), (9.10). For bands as described by Eqs. (1.6) and (1.7), i.e., neglecting spin, the densities of states with and without magnetic fields are illustrated in Fig. 24, and it is these forms which primarily determine the nature of the interband-magneto (IMO) absorption spectrum for direct transitions. The absorption coefficient is formed from

$$\alpha(\omega, B) = A \sum_{nn'} \sum_{ll'} \int dk_z\, dk_z\, |\langle c|\alpha \cdot p|v\rangle|^2\, \delta[E_{cn'}(k_z) - E_{vn}(k_z) - \hbar\omega] \tag{21.4}$$

and gives

$$\alpha(\omega, B) = A' \left(\frac{\hbar e B}{2m^*}\right) \sum_n (\hbar\omega - \varepsilon_n)^{-\frac{1}{2}} \tag{21.5}$$

for the allowed direct transition, where $\varepsilon_n = E_G + (n + \frac{1}{2})\hbar\omega_c + (g_c M_c - g_v M_v)\beta B$ and $\hbar\omega_c = \frac{eB}{m^*}$, m^* is the *reduced* mass as above. The spins have been re-introduced as in (9.13) and (9.14) and $\beta = \frac{e\hbar}{2m}$.

The selection rules for direct interband transitions were discussed in Sect. 11. For simple bands

$$\Delta n = 0 \quad \text{and} \quad \Delta M = 0, \pm 1$$

and the particular values of ΔM are dependent upon the state of polarisation and relative orientation of the magnetic field as discussed in Sect. 11. The shape of the absorption spectrum will be modified by broadening of the energy levels. Each electronic transition can be empirically treated by including Lorentzian broadening. The IMO lines are also broadened by transitions away from $k_z=0$ which convert the IMO lines of $k_z=0$ into extended absorption bands. The tails of these bands results from the quasi-continuous nature of the energy bands in the z direction and the different curvature (in sign as well as magnitude) of the valence and conduction bands. Typical calculated curves of IMO absorption for a simple semiconductor are shown in Fig. 25.

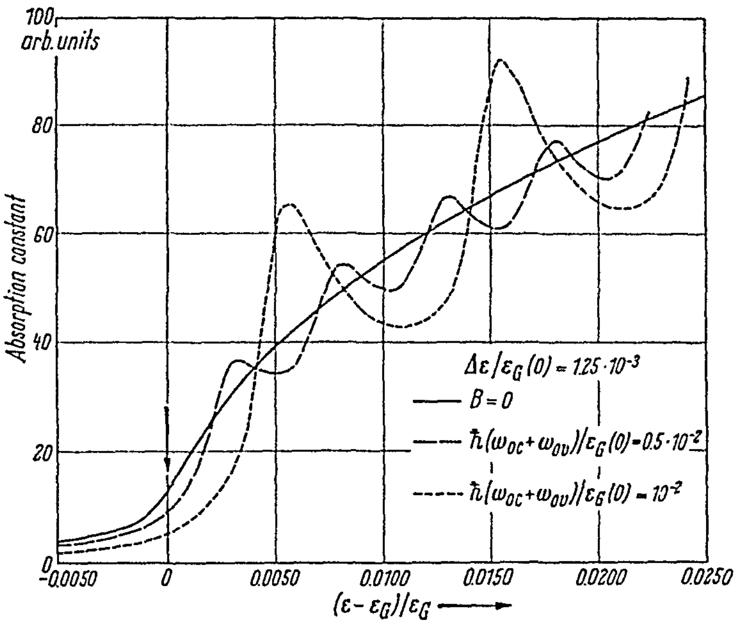

Fig. 25. Calculated I.M.O. absorption spectrum for simple bands (after BURSTEIN et al., Ref. 4, p. 257).

The matrix elements, as discussed in Sect. 11, are functions of magnetic field and are given from Eq. (11.3). In the *absence* of a magnetic field the matrix element can be extended

$$\langle c|\boldsymbol{\alpha}\cdot\boldsymbol{p}|v\rangle=\left[\boldsymbol{\alpha}\cdot\boldsymbol{p}_{cv}(0)+\boldsymbol{k}\left[\frac{\partial}{\partial k}\boldsymbol{\alpha}\cdot\boldsymbol{p}_{cv}(\boldsymbol{k})\right]_{k=0}+\cdots\right] \tag{21.6}$$

and we write

$$\frac{\partial}{\partial k}\left[\boldsymbol{\alpha}\cdot\boldsymbol{p}_{cv}(\boldsymbol{k})\right]_{k=0}=\mathrm{M}_{cv}(0).$$

If $\boldsymbol{p}_{cv}(0)\neq 0$ we have the case of *allowed transitions* and all terms except $\boldsymbol{\alpha}\cdot\boldsymbol{p}_{cv}(0)$ will be negligible. In the presence of a magnetic field the matrix elements for $v_\pm$ from (11.3) imply a difference from the term $\left(1+\frac{eB}{m\,\omega_g}\right)$ in which m is the free mass. For a field of 100 kgauss this term differs from 1 by 10^{-2}—10^{-3} for most semiconductors and hence is negligible in absorption processes. It can however be significant in processes depending upon differences between v_+ and v_-, such as Faraday effect.

When $p_{cv}(0)=0$, the second term in the expansion, $\mathrm{M}_{cv}(0)$, becomes important and we have the case of *forbidden transitions.* There are two cases:

(a) $E\parallel B$

$$\alpha(\omega,B)=\frac{3\hbar\,\omega_c A''}{2}\sum_n\left[\hbar\,\omega_c-\varepsilon_n\right]^{\frac{1}{2}}$$

where

$$A'' = \frac{e^2 \hbar^2}{6\pi n m^2 c \omega \varepsilon_0} |\mathrm{M}_{cv}(0)|^2 \left(\frac{2m^*}{\hbar^2}\right)^{\frac{5}{2}}$$

and

$$\varepsilon_n = E_G + (n+\tfrac{1}{2})\hbar\omega_c + (M_c g_c - M_v g_v)\beta B$$

with selection rules $\Delta n = 0$, $\Delta M = 0$.

(b) $E \perp B$

$$\alpha(\omega, B) = \frac{3}{2}\left(\frac{\hbar\omega_c}{2}\right)^2 A'' \sum_n (n+1)\left[(\hbar\omega - \varepsilon_{n_1})^{-\frac{1}{2}} + (\hbar\omega - \varepsilon_{n_2})^{-\frac{1}{2}}\right]$$

where

$$\varepsilon_{n_{1,2}} = E_G + (n+\tfrac{1}{2})\hbar\omega_c + (M_c g_c - M_v g_v)\beta B + \hbar\omega_{c_{1,2}}$$

with selection rules $\Delta n = \pm 1$ and $\Delta M = \pm 1$.

This predicts two series of massing (neglecting spin) with intensity increasing with n. Forbidden transitions apply, for example, to the case of cuprous oxide[1].

For Ge, InSb etc. the allowed transition case is appropriate but must be modified to include the degenerate valence bands, and also non-parabolic bands when necessary. The Luttinger-Kohn results for the magnetic levels in the valence states given by (10.18) and (10.19) are then combined with conduction states given by

$$E_c = E_{c0} + \frac{\hbar^2 k_z^2}{2m_c} + \hbar\omega_{cc} + g_c\beta B \tag{21.7}$$

which parabolic form is relevant to the Γ_2 conduction band minimum at $k=0$ in Ge (i.e., not the lowest minimum occurring in the $\langle 111 \rangle$ direction which gives rise to indirect processes). From (10.18), (10.19) and (21.7) the energies of the IMO transitions can be predicted, and taking into account the polarisation of radiation and relative direction of the magnetic field the appropriate transition probabilities have been calculated using the wave functions given by (10.15), (10.16) and (10.17). The resulting selection rules were summarised in Sect. 11. Analysis of experimental results has taken the form of a comparison of the position and strengths of the IMO lines with the observed spectrum rather than a calculation of the detailed shape.

The earliest measurements and the detailed analysis of results are contained in a series of papers from the N.R.L. and M.I.T. Laboratories published almost simultaneously and containing nearly identical material. The first experiments were carried out on InSb[2] and InSb and InAs[3] in which the specimens were thick so that only an edge shift was observed. With thinner specimens the resonant oscillatory effects were then observed in InSb[4] and for the direct transition in Ge[5]. Detailed results and analysis for the germanium case have been given by both groups[6–8], the high resolution low temperature data from the Lincoln Laboratory[7] being the most complete experimental results.

Results for plane polarised radiation with $E \| B$ and $E \perp B$ when B was along the [1 0 0] axis are shown in Fig. 26, together with predicted positions and strengths of the lines from the Lincoln results[8]. The theoretical line positions were predicted

[1] E. F. Gross: J. tech. Phys. (Moscow) **27**, 2177 (1957).
[2] E. Burstein, G. S. Picus, H. A. Gebbie, and F. Blatt: Phys. Rev. **103**, 826 (1956).
[3] S. Zwerdling, R. F. Keyes, S. Foner, H. H. Kohn, and B. Lax: Phys. Rev. **104**, 1805 (1956).
[4] E. Burstein, and G. Picus: Phys. Rev. **105**, 1123 (1957).
[5] S. Zwerdling, B. Lax, and L. Roth: Phys. Rev. **108**, 1402 (1957).
[6] E. Burstein, G. S. Picus, R. F. Wallis, and F. Blatt: Phys. Rev. **113**, 15 (1959).
[7] S. Zwerdling, B. Lax, L. M. Roth, and K. J. Button: Phys. Rev. **114**, 80 (1959).
[8] L. M. Roth, B. Lax, and S. Zwerdling: Phys. Rev. **114**, 90 (1959).

using the method outlined making use of Eq. (10.18), (10.19) and (21.7). The valence band parameters γ_1, γ_2, γ_3 and κ were obtained from DEXTER, ZEIGER and LAX[1] and the spectra had to be "stretched" by 1.11% to obtain the fit illustrated, taking the band edge at 0.9870 eV. The prominent features (minima in I_B/I_0) then fit quite reasonably except lines 1, 1′ and 3, 3′. Quantitative results are best deduced from such data by plotting the positions of successive minima as a function of magnetic field. The lines 1, 1′ and 3, 3′ are found to have a quadratic

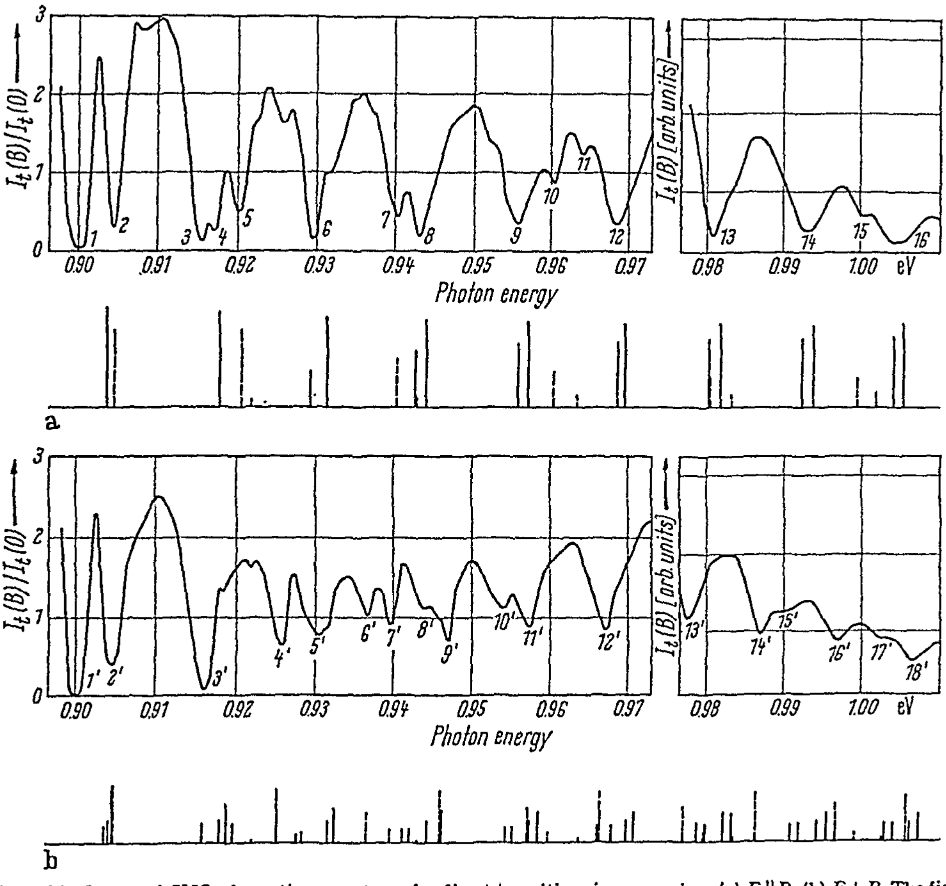

Fig. 26a and b. Observed IMO absorption spectrum for direct transitions in germanium (a) $E \parallel B$, (b) $E \perp B$. The field was 38.9 kilogauss along [100] axis. The solid lines in the lower half of the figures represent the theoretical position and strength of the heavy — hole transitions and the dotted lines the light hole transitions (after ROTH, LAX and ZWERDLING et al., Ref. 8, p. 289).

dependence upon field at low fields and to persist as absorption peaks down to zero field. They are therefore assigned to exciton transitions (see Sect. 22). The Landau levels behave linearly at high fields (Fig. 27) and the plots of successive minima converge when extrapolated to zero field, to yield accurate values of the energy gap. This is probably the most certain and accurate technique of all for obtaining energy gaps in semiconductors.

The selection rules for the $E \parallel B$ and $E \perp B$ spectra of Fig. 26a and b differ with the consequence that the prominent minima in the $E \parallel B$ case correspond to transitions from *heavy hole* levels while for $E \perp B$ (Fig. 26b) the transitions from *light hole* levels appear most strongly. Thus an important separation can be made (see Fig. 28).

The experiment was also carried out with B along [110] and [111] axes giving a measure of the anisotropy of the energy surfaces.

[1] R. N. DEXTER, H. J. ZEIGER, and B. LAX: Phys. Rev. **104**, 637 (1956).

The *slope* of the plot of position of IMO peaks versus magnetic field can be directly interpreted in terms of the cyclotron frequency corresponding to the *reduced* mass m^*. Considering then the heavy hole transitions, which have the smaller splitting, and including the heavy hole mass from cyclotron resonance results ($m^{111}=0.54$, $m^{100}=0.46$) the *conduction band mass* can be deduced. In the case of direct transitions this is the mass associated with the Γ_2 minimum at $k=0$ and the Lincoln Laboratory results give a value of $(0.037\pm0.001)\,m_0$. This experimental determination is an example of the usefulness of IMO techniques as it would not have been possible by CR methods to reach such a higher conduction band minimum. However some independent knowledge of the valence band is required.

When the IMO lines have been identified it is also possible to obtain values for the conduction band spin splitting. The transitions 7 and 7′ come from the same

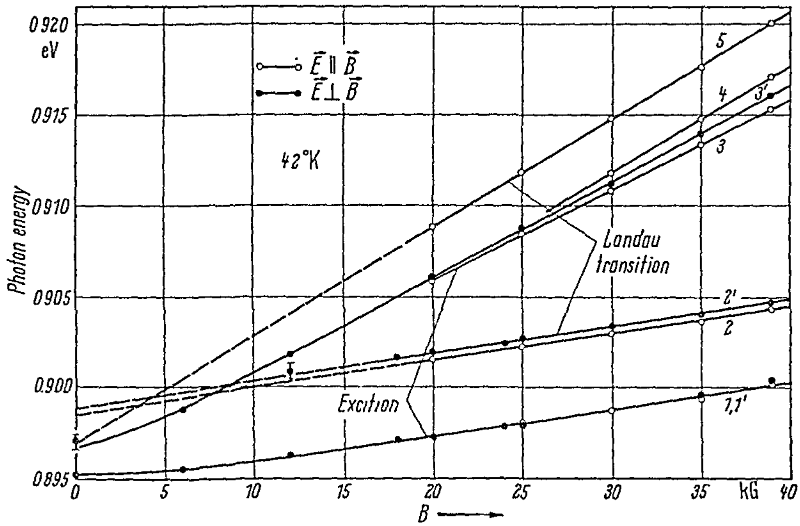

Fig. 27. Magnetic field dependence of position of I.M.O. peaks in germanium (after ZWERDLING et al., Ref. 7, p. 289).

valence state to the upper and lower states spin split from the same conduction band Landau level. The separation yields a g-factor of -3.1. ROTH et al. find that the energy levels can be fitted by the expression

$$\varepsilon_n=(27.1\pm0.6)\,(n+\tfrac{1}{2})\,\hbar\,\omega_0-(0.33\pm0.1)\,(n+\tfrac{1}{2})^2\,(\hbar\,\omega_0)^2\mp 1.2\,\beta B \tag{21.8}$$

where ω_0 is the free mass CR frequency. The second term is due to the non-parabolicity of the conduction band which is a fairly small effect over the range of the experiments described. The expression (21.8) yields a g-factor of -2.5.

The effects of anomalous g-factor, and of non-parabolic conduction bands are much greater in InSb than in Ge. The early measurements on InSb have been referred to previously, while in Fig. 29 is shown the more recent results of ZWERDLING, KLEINER and THERIAULT[1,2], in which polarised radiation, low temperatures and high resolution grating spectroscopy were used. Detailed spectra extending deep into the band were obtained in the range from 0.2300 eV, the 5° K energy

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[1] S. ZWERDLING, W. H. KLEINER, and J. P. THERIAULT: J. Appl. Phys., Suppl. 32, 2118 (1961).

[2] S. ZWERDLING, W. H. KLEINER, and J. P. THERIAULT: Proc. Int. Conf. on Physics of Semiconductors, Exeter, 1962, p. 455 (1962).

gap, to 0.4530 eV. When plotted against magnetic field the positions of the minima lay on a curve, indicating the non-parabolicity of the conduction band. Transitions involving heavy hole quantum numbers up to $n=27$ were observed. An earlier

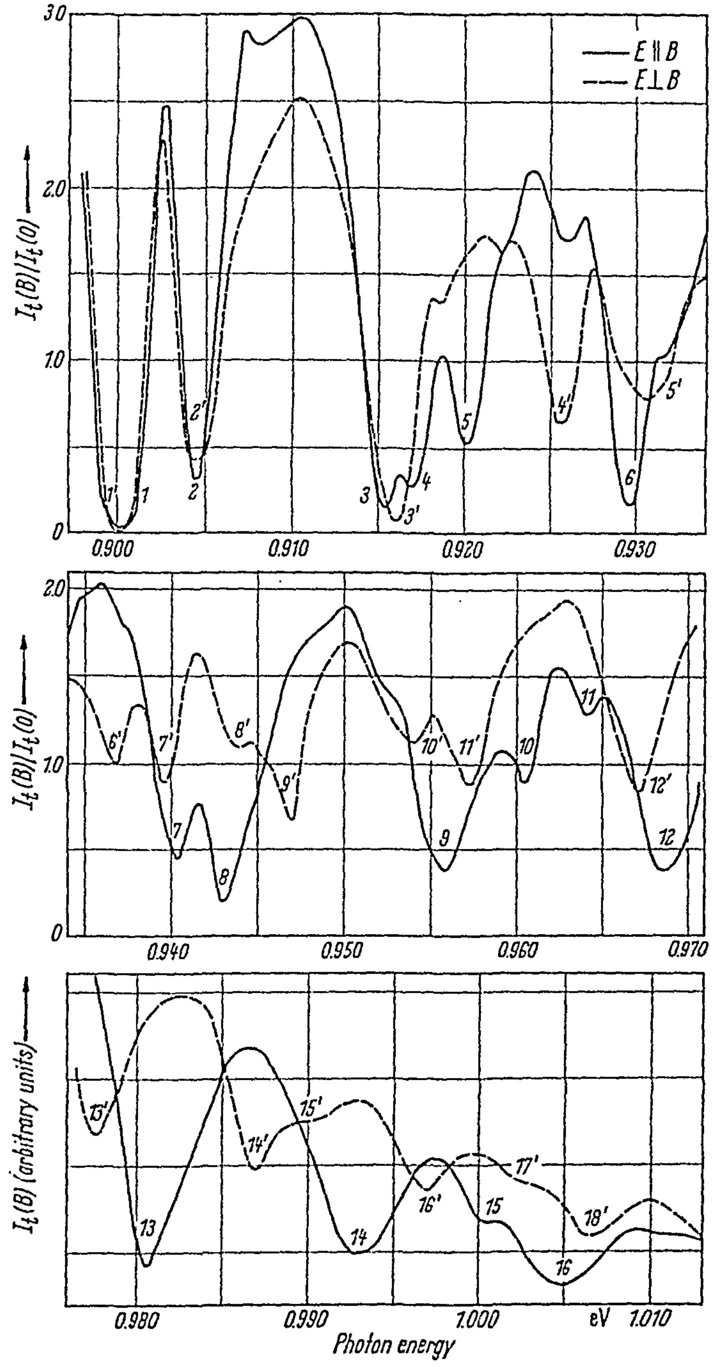

Fig. 28. The change in IMO spectra between $E \parallel B$ (full line) and $E \perp B$ (dotted line) in germanium at 4.2° K and 38.9 kgauss (after Zwerdling et al., Ref. 7, p. 289).

convergence plot, at room temperature is shown in Fig. 30, giving a zero field energy gap of 0.180 ± 0.002 eV at room temperature. This graph also shows the anomalous spin splitting of the 1st Landau level. The g-factor determined from the separation is approximately -54. This value is in agreement with the predic-

tion of ROTH [Eq. (12.1)], but care must be taken to use an appropriate value for m_c^*. Since m_c^* varies in the non-parabolic band, so too does the g-factor.

Using polarised radiation with $E \parallel B$ to pick out the heavy hole transitions, the anisotropy of the valence band was investigated (assuming the conduction band

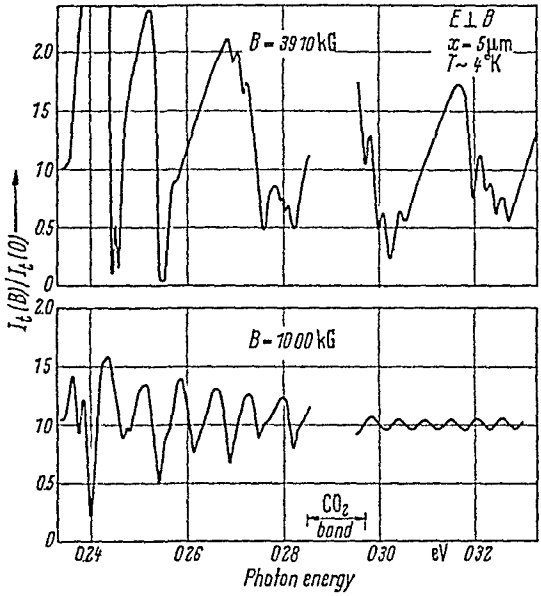

Fig. 29. High resolution IMO spectra for InSb at liquid helium temperature with $E \perp B$ (after ZWERDLING et al., Ref. 1, p. 291).

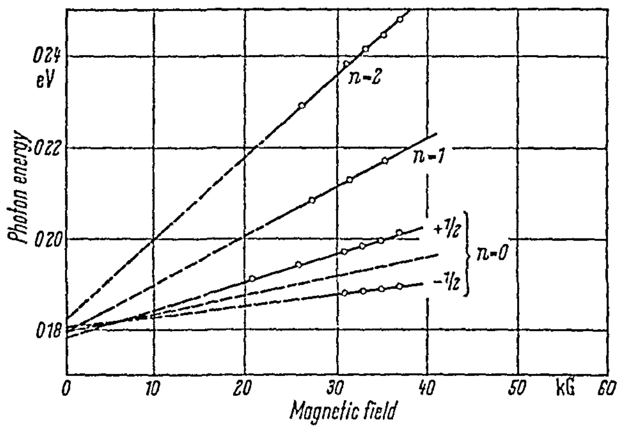

Fig. 30. Convergence plot for IMO spectra of InSb at room temperature. The first level ($n=0$) is split by spin ($+\frac{1}{2}$, $-\frac{1}{2}$). The separations giving a g value for the conduction electron of −54 (after ZWERDLING et al., Ref. 3, p. 286).

to have spherical energy surfaces). The results for three principal crystallographic directions are given in Fig. 31. They can be expressed in terms of the parameters of the Luttinger-Kohn theory discussed earlier. The valence band anisotropy is found to be somewhat smaller than in Si and Ge. If the valence bands are approximated to spheres, a result we require in Sect. 23, the results can be expressed in terms of the three parameters γ, $\bar{\gamma}$ and κ [Eq. (9.11)] as follows:

γ	$\bar{\gamma}$	κ	
25.0	11.0	10.13	CR
36.0	15.35	13.87	IMO

in which the second set is derived from the IMO measurements. The first set is from recent CR measurements of BAGGULEY and STRADLING[1] and differs significantly from the IMO results. In Sect. 23 we shall see that the CR values give a better fit to resonant interband Faraday rotation. A heavy hole mass $\sim 0.02\, m_0$ is implied by the IMO results[2,3].

Other materials studied by IMO methods include InAs[4] and GaSb[4], resembling InSb and germanium respectively, CdS[5] and the lead salts PbS, PbSe, PbTe[6]. The two latter cases have somewhat different band structure than Ge, InSb etc., with the CdS case showing strong exciton effects which will be further discussed in Sect. 22.

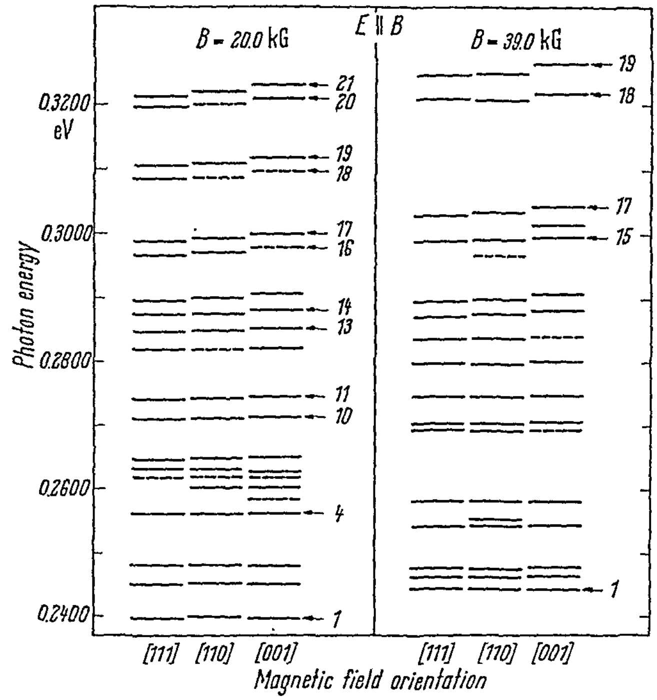

Fig. 31. Magnetic energy levels for $E \parallel B$ as a function of crystallographic direction in InSb, illustrating the anisotropy of the valence band (after ZWERDLING et al., Ref. 2, p. 291).

The lead salt studies were made with epitaxial evaporated films 2—4 microns thick both with samples freed from the substrate and others still attached. In the latter case there was strain present. The band structure of PbS, PbTe and PbSe has attracted a great deal of attention for some years. Only recently has the band edge structure become clear due to experiments on de Haas-van Alphen oscillatory magnetic susceptibility[7], Shubnikov-de Haas oscillatory magneto resistance[8],

[1] D. M. S. BAGGULEY, and R. A. STRADLING: Phys. Letters 6, 143 (1963).

[2] More complete IMO and Resonant Faraday rotation data have recently been given by C. R. PIDGEON, and R. N. BROWN, Phys. Rev. 146, 515 (1966). The results are analysed by a much more adequate theory in which conduction and valence band coupling is treated exactly and higher bands to order k^2. Band parameters at 20° K are quoted as $m_c = 0.0145$ m, $m_{lh} = 0.0160$ m, $m_{hh}[100] = 0.32$ m, $m_{hh}[110] = 0.42$ m, $m_{hh}[111] = 0.44$ m.

[3] E. J. JOHNSON, and D. M. LARSEN: Phys. Rev. Letters 16, 655 (1966), have observed non-linear shifts of IMO peaks when $\hbar\omega_{cc} \simeq \omega_{LO}$; they assign the peaks to a polaron doublet.

[4] See B. LAX, and S. ZWERDLING: Progr. in Semiconductors 5, 231 (1960).

[5] A. MISA, K. AOYAGI, and G. KUWABARA: Proc. Int. Conf. on Physics of Semiconductors, Paris, 1964, p. 317.

[6] D. L. MITCHELL, E. D. PALIK, and J. N. ZEMEL: Proc. Int. Conf. on Physics of Semiconductors, Paris, 1964, p. 325.

[7] See W. W. SCANLON: Solid State Physics 9, 83 (1959) for a review.

[8] K. F. CUFF, M. R. ELLETT, and C. D. KUGLIN: Proc. Int. Conf. on Physics of Semiconductors, Exeter, 1962, p. 316.

Azbel-Kaner cyclotron resonance[1] in addition to the IMO work reviewed here. All these experiments indicate that for all three materials the valence and conduction band extrema have $\langle 111 \rangle$ symmetry and occur at the same point in k-space, probably the L point at the $\langle 111 \rangle$ edge of the Brillouin zone. The IMO results indicate that both valence and conduction bands are non-degenerate except for spin and, therefore, the Landau levels will be described by Eqs. (9.13) and (9.14) with appropriate masses substituted, since the energy surfaces are essentially *ellipsoids* and the cyclotron frequency will depend on the average effective mass for motion in a plane perpendicular to the magnetic field. The effective mass m_i, where i is the band index, is

$$\frac{1}{(m_i^\Theta)^2} = \frac{1}{(m_i^t)^2}\left[\cos^2\Theta + \frac{1}{k_i}\sin^2\Theta\right]$$

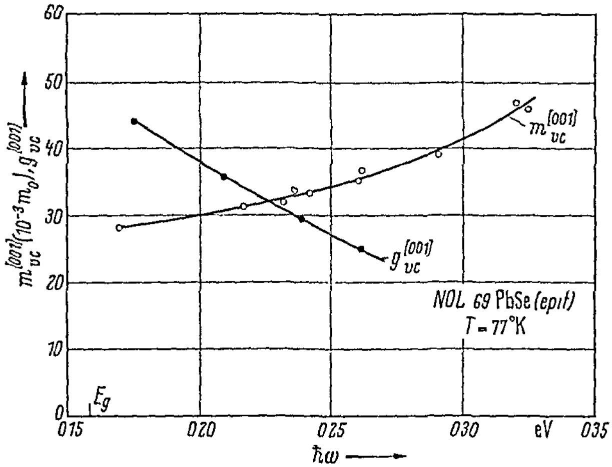

Fig. 32. Reduced effective mass $m_{vc}^{[001]}$ and effective g-factor $g_{vc}^{[001]}$ for PbSe deduced from IMO measurements (after Mitchell et al., Ref. 6, p. 294).

where Θ is the angle between ellipsoid axis and magnetic field, m_i^t is the transverse mass and k_i the ratio m_i^l/m_i^t.

With $\langle 111 \rangle$ oriented ellipses, a single set of resonances is observed with B along a $\langle 100 \rangle$ axis, while for other field directions there is more than one set of ellipsoids with equivalent orientation. The measurements of Mitchell, Palik and Zemel were made, for PbS and PbSe, with B along [001] direction for radiation propagating perpendicular to B and oriented with $E \perp B$. A single set of regularly spaced Landau transitions was observed. The energies were described by

$$E_n = E_G + (n + \tfrac{1}{2})\hbar\,\omega_{vc}^\Theta$$

where $\omega_{vc}^\Theta = \omega_v^\Theta + \omega_c^\Theta$ and $\Delta M = 0$. Each line splits into a doublet for $E \parallel B$ when $\Delta M = \pm 1$. Convergence plots were used to deduce energy gaps and the effects of strain and from the latter a deformation potential was estimated. The lack of splitting of the $E \parallel B$ spectra for PbS and PbSe indicates that $g_c^\Theta = -g_v^\Theta$. Magnitudes of effective g-factors were deduced from $E \perp B$ spectra (Fig. 32). Values of reduced effective mass are also plotted in Fig. 32, obtained from slopes of the convergence plot; they exhibit some non-parabolicity. The anisotropy of the reduced mass is shown in Fig. 33.

[1] P. J. Stiles, E. Burstein, and D. N. Lengenberg: Proc. Int. Conf. on Physics of Semiconductors, Exeter, 1962, p. 316.

It is apparent that the IMO technique is very rich in the interpretable quantitative information that can be extracted from measurements of direct transition processes. We have, so far, excluded the effects of *indirect transitions* and *excitons* which, in certain materials, notably Ge and CdS, complicate the spectra in certain regions.

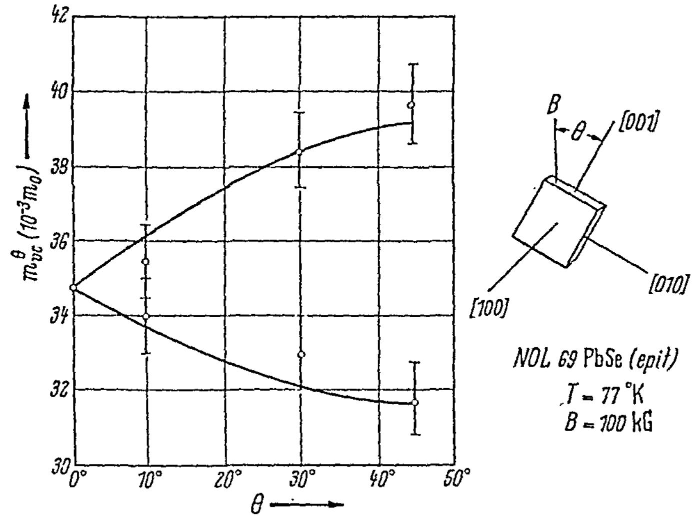

Fig. 33. Anisotropy of reduced effective mass (after MITCHELL et al., Ref. 6, p. 294).

22. Indirect magneto-absorption and excitons. In the description of the primary interband magnetoabsorption processes due to direct transitions we have, so far, neglected effects concerned with the Coulomb interaction between the electron and hole. These interactions give rise to exciton effects, particularly strong in ionic materials of large energy gap, such as Cu_2O and CdS, but present to some extent in all crystals.

Further complication occurs when the minimum energy gap occurs between band extrema located at different points in k-space, and excitons can be associated with both direct and indirect energy gaps.

α) *Indirect transitions and magneto-absorption.* The indirect gap gives rise to absorption in the zero field case which is weak compared to the direct transition effect. This arises as it is a second order process made possible by the interaction of phonons. It is therefore only observable when the indirect gap is less than the direct gap, and it shows a characteristic temperature dependence associated with the phonon populations. The absorption coefficient is of the form

$$\alpha(0) = C_{\pm}[\hbar\omega - E_G \mp \hbar\omega_q]^2$$

where $\hbar\omega_q$ is the phonon energy and C involves the phonon population and fundamental constants. Such a situation applies to germanium with the conduction band minima occurring in the $\langle 111 \rangle$ direction at the zero boundary. In the presence of a field the absorption is given by

$$\alpha(B) = 2C_{\pm}(\hbar^2\omega_{c_1}\omega_{c_2}) \sum_{n_1 n_2} S(h - \varepsilon_{n_1 n_2})$$

where

$$\varepsilon_{n_1 n_2} = E_G + (n_1 + \tfrac{1}{2})\hbar\omega_{c_1} + (n_2 + \tfrac{1}{2})\hbar\omega_{c_2} \pm \hbar\omega_q + (M_c g_c - M_v g_v)\beta B \quad (22.1)$$

and $S(\hbar\omega - \varepsilon_{n_1 n_2})$ is a step function.

The presence of phonon interaction relaxes the selection rules on the Landau orbital quantum numbers n_1 and n_2 but the rules for spin quantum number

$M(\Delta M=0\ E\|B,\ \Delta M=\pm 1\ E\perp B)$ still hold. Eq. (22.1) predicts a spectrum consisting of a series of "steps". Between each step the absorption is roughly constant with frequency and is proportional to B^2. Convergence plots may be made from the step positions (found to be linear with field) which yield accurate values of indirect energy gaps[1]. A further "step" in the spectrum is interpreted as an indirect exciton, and shows a quadratic dependence of its position upon magnetic field[2].

β) Zeeman effect of excitons. An exciton consists of an electron and hole bound together electrostatically; when the pair has energy less than that of an energy gap they orbit around each other. If the orbits are large compared with the lattice constant they can be treated approximately as two point charges having effective masses and bound together by a Coulomb potential to give rise to a hydrogen-like series of energy levels and hence a line spectrum at energies lying in the forbidden gap. In the presence of magnetic fields excitons give rise to Zeeman effects analogous to those in atomic spectra. Fine structure can occur due to motions other than the simple orbiting of electron and hole: the carriers can have intrinsic motion, motion around an atom, spin motion and motion of the complete exciton through the lattice. Some of these motions may be coupled together. The importance of exciton effects depends upon the binding energy given by

$$E_{\mathrm{ex}} = -(\mu/m)\,\varepsilon_0^2/n^2\,\varepsilon^2 \times 13.5 \text{ eV}$$

where μ is the reduced hole-electron mass and ε the permittivity.

This energy tends to be small in materials of small energy gap (e.g., 10^{-4} eV in InSb) and increases with energy gap. Experimental work has tended to concentrate upon favourable systems, in particular cuprous oxide (Cu_2O) and cadmium sulphide (CdS). The Zeeman effect in Cu_2O was observed by GROSS and ZAHARČENJA[3] in 1957. It was found that the lines in the exciton series did not display a paramagnetic Zeeman effect proportional to the magnetic field but a diamagnetic shift proportional to the *square* of the field. The experiments were in agreement with the theory of the quadratic Zeeman effect, the shift being proportional to the square of the electron orbit radius and so to the fourth power of the quantum number. Quite large (400 Å) exciton orbits were implied. The interband transitions in Cu_2O are an example of a forbidden transition (Sect. 21) and the excition spectrum has been interpreted by ELLIOTT[4,5] in terms of indirect processes and quadrupole transitions. Further extension of the experiments[6,7] using also Stark effects and strain have enabled some band parameters to be deduced.

The general problem requires the solution of the Schrödinger equation

$$\left[-\frac{\hbar^2}{2\mu}\nabla^2 + \frac{ie\hbar}{2}\frac{m_e m_h}{(m_e-m_h)}\boldsymbol{B}\cdot\boldsymbol{r}\cdot\times\nabla + \frac{e^2}{8\mu}(\boldsymbol{B}\times\boldsymbol{r})^2 - \frac{e^2}{\varepsilon r}\right]u(r) = E\,u(r)$$

[1] See, for example, B. LAX, and S. ZWERDLING: Progr. in Semiconductors 5, 221 (1960). — R. J. ELLIOTT, T. P. MCLEAN, and G. G. MACFARLANE: Proc. Phys. Soc. (London) 72, 553 (1958).

[2] New and extended results for the indirect transition in germanium have been given recently by J. HALPERN and B. LAX, J. Phys. Chem. Solids 26, 911 (1965).

[3] E. F. GROSS, and B. P. ZAHARČENJA: J. Phys. Radium 1, 68 (1957). — E. F. GROSS: J. Phys. Chem. Solids 8, 172 (1959).

[4] R. J. ELLIOTT: Proc. Int. Conf. on Semiconductor Physics, Prague 1960, p. 408.

[5] R. J. ELLIOTT: Phys. Rev. 124, 340 (1961).

[6] E. F. GROSS, B. P. ZAHARČENJA, and A. A. KAPLANSKY: Proc. Int. Conf. on Physics of Semiconductors, Exeter 1962, p. 409.

[7] S. NIKITINE et al.: Proc. Int. Conf. on Physics of Semiconductors, Exeter 1962, p. 409.

where m_e is the effective electron mass, m_h is the effective hole mass, $\mu = \frac{m_e + m_h}{m_e m_h}$, the reduced mass, and ε is the dielectric constant of the crystal. The term in B^2 gives the quadratic Zeeman splitting which becomes dominant as B increases.

A detailed study and analysis for the case of CdS has been made by HOPFIED and THOMAS[1]. In this material the valence band is split by spin orbit and crystal field effects into three nearly degenerate bands at $k=0$. Excitons formed from the top valence band and the conduction band are considered and the spectrum was analysed quantitatively. An electron mass (0.20 m), almost isotropic was found, with the assumption of a lowest minimum at $k=0$ and hole masses of $m_{h\perp}=0.7$ m and $m_{h\parallel}=5$ m where $\perp$ and $\parallel$ refer to the hexagonal c-axis of the crystal. Electron and hole g-factors were also deduced. CdSe has been similarly studied by DIMMOCK and WHEELER[2].

Exciton effects in germanium were mentioned in Sect. 21. The characteristic quadratic dependence of the position of the exciton line and field is shown in Fig. 27. Excitons in germanium can arise from both the indirect and direct energy gaps. These studies have been extended by EDWARDS, LAZAZZERA and PETERS[3] who consider the effects of strain and high magnetic field upon the direct exciton in germanium. Using unstrained samples they make precise observations and note that the interband Landau levels are affected by discrete exciton effects as predicted by ELLIOTT and LONDON[4] and also HOWARD and HASEGAWA[5]. These effects are dominant when $\hbar\omega_c \gg \hbar\omega_{\mathrm{ex}}$, and $\hbar\omega_{\mathrm{ex}}$ is the exciton binding energy. At zero field $\hbar\omega_{\mathrm{ex}}=0.0017$ eV for Ge but increases quadratically with field.

Exciton effects can also influence interband Faraday and Voigt effects as well as magneto-absorption (Sect. 23α).

23. Interband Faraday rotation and Voigt effects. The non-resonant Faraday effect arises from the dispersion associated with the interband magneto-absorption which was described in Sect. 21. Each IMO absorption peak has a corresponding dispersion resonance and the summation of the tails of these dispersion curves which entend to photon energies lying in the band gap gives rise to the non-resonant interband effects in both Faraday rotation and Voigt effects. It is therefore instructive to consider the resonant effects first although they have only recently been observed. The resonant effect is simpler theoretically in that the effect is dominated by the nearest magneto-optical transition whereas off-resonance the effect of a large number of transitions has to be estimated.

α) *Resonant interband Faraday effect.* Faraday rotation spanning large oscillations at the energies of the Landau levels was observed simultaneously and independently by NISHINA, KOLODZIEJCZAK and LAX[6] in Ge and by SMITH, PIDGEON and PROSSER in InSb[7] both experiments being reported at the Exeter Semiconductor Conference in 1962. A further observation on Ge including also ellipticity measurements was made by MITCHELL and WALLIS[8]. The germanium case is somewhat complicated by exciton effects whereas for InSb with an exciton

[1] J. J. HOPFIELD, and D. G. THOMAS: Phys. Rev. **122**, 35 (1961).
[2] J. O. DIMMOCK, and R. G. WHEELER: J. Appl. Phys. **32**, 227 (1961).
[3] D. F. EDWARDS, V. J. LAZAZZERA, and C. W. PETERS: Proc. Int. Conf. on Semiconductor Physics, Prague 1960, p. 335.
[4] R. J. ELLIOTT, and R. LOUDON: J. Phys. Chem. Solids **15**, 196 (1960).
[5] H. HASEGAWA, and R. E. HOWARD: J. Phys. Chem. Solids **21**, 179 (1961).
[6] Y. NISHINA, J. KOLODZIEJCZAK, and B. LAX: Phys. Rev. Letters **9**, 55 (1962).
[7] S. D. SMITH, C. R. PIDGEON, and V. PROSSER: Proc. Int. Conf. on Physics of Semiconductors, Exeter 1962, p. 301.
[8] D. L. MITCHELL, and R. F. WALLIS: Phys. Rev. **131**, 1965 (1963).

binding energy $\sim 10^{-4}$ eV such effects are negligible. The oscillating rotation in InSb is illustrated in Fig. 34 together with the corresponding IMO spectrum. The energies and strengths of the allowed transitions for right and left circularly polarised radiation are given in Fig. 35. As computed by BOSWARVA[1] using the Luttinger-Kohn model and the valence band parameters discussed in Sects. 14 and 21, together with $m_c^* = 0.0145$ m, $g_c = -47.2$ to describe the conduction band levels and $E_G = 0.228$ eV at 77° K. The shape of the Faraday rotation curve at resonances can be understood by taking a simple case. Since the Faraday rotation is given by

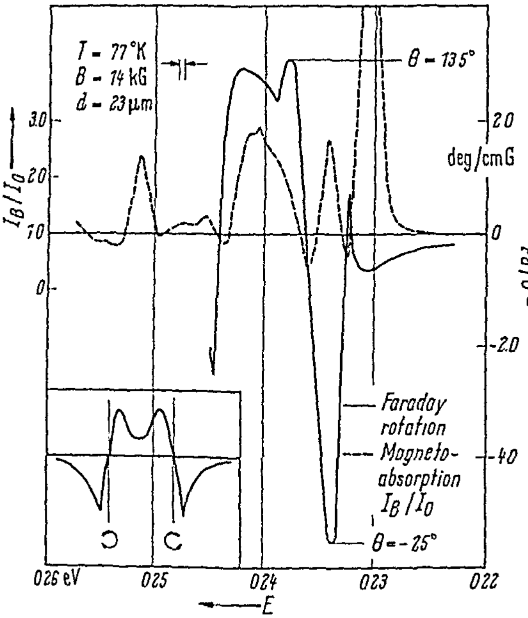

Fig. 34.

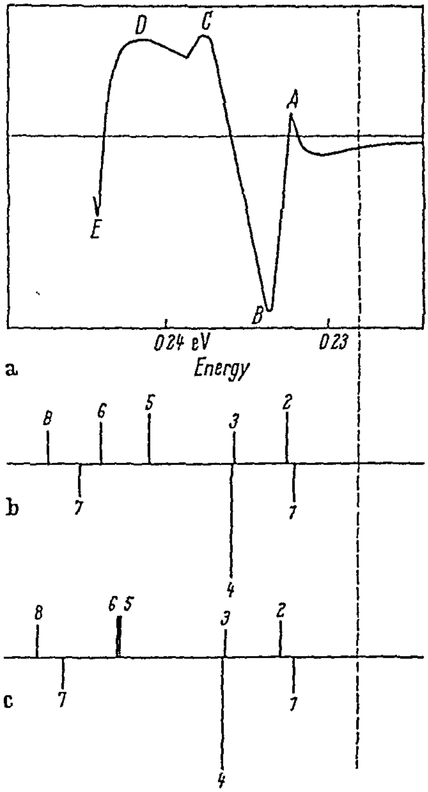

Fig. 35.

Fig. 34. Resonant interband Faraday rotation in InSb (full line) and for comparison the IMO spectrum (dotted line). Inset: resonant Faraday rotation at a simple pair of transitions (after SMITH et al., Ref. 7, p. 298).

Fig. 35. (a) Faraday rotation through the absorption edge region in InSb at 77° K using $B = 14$ kgauss. (b) Energies and strengths of allowed transitions, at $K = 0$, computed from the Kohn-Luttinger model using the band parameters of BAGGULEY and STADDLING. (c) As (b) using band parameters of ZWERDLING et al. (after BOSWARVA[1]).

$$\Theta = \frac{\omega l}{2c} (n_+ - n_-)$$

n_+ and n_- will respectively show a characteristic dispersion resonance at the energy appropriate to a transition for r.c.p. and l.c.p. radiation respectively and since the *difference* is measured one dispersion resonance will be inverted. Thus the rotation will behave as in Fig. 34 (inset) for single energy levels. In real cases the transitions are between magnetic sub-bands, involving nearby states from heavy hole and light hole ladders. These may sometimes be of opposite sign. This sensitivity to sign enables the oscillatory Faraday effect to distinguish between different types of transition unlike magneto-absorption in which effects are, of course, only additive. For InSb, BOSWARVA also calculated detailed shape, including Lorentzian broadening and, as shown in Fig. 35, obtains good agreement

[1] I. M. BOSWARVA: Proc. Phys. Soc. (London) 84, 389 (1964).

between the positions of the magnetic levels and the observed resonances. The structure in the region A is due to the effects of a positively contributing pair of bands with a negative pair preceding them by 0.001 eV and the analysis is consistent with the first four transitions being respectively from light hole, heavy hole, heavy hole, light hole states in agreement with magneto absorption results. Better agreement is obtained using the valence band parameters of BAGGULEY and STRADLING than those of ZWERDLING et al. (Sect. 21) in the approximation that the valence bands are considered to be spherical.

Experimental results for oscillatory Faraday rotation and ellipticity in Ge, measured by MITCHELL and WALLIS, are shown in Fig. 36 for a field of 86 kgauss.

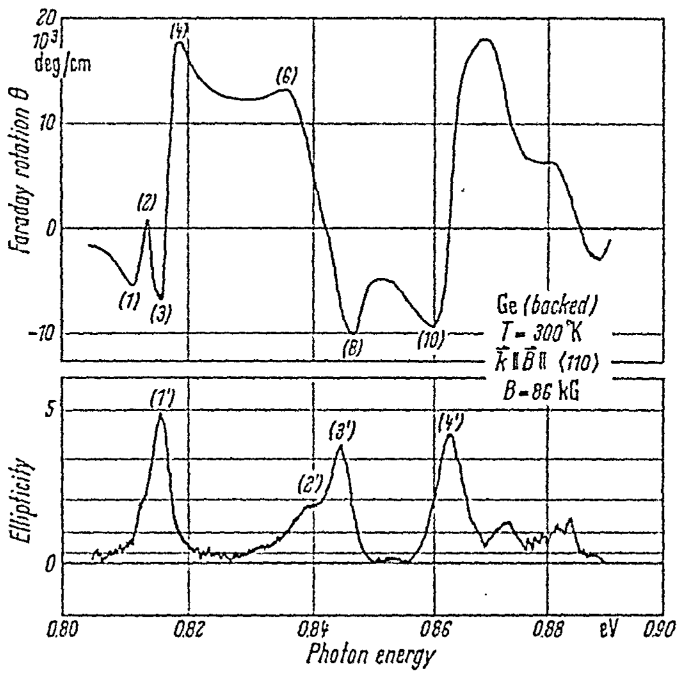

Fig. 36. Resonant Faraday rotation and ellipticity for germanium (after MITCHELL and WALLIS, Ref. 8, p. 298).

Since this field is in the strong field range ($\hbar\,\omega_c \gg \hbar\,\omega_{cx}$) for exciton effects, these authors examine the line shape of the peak labelled l' in ellipticity and find it consistent with the exciton line shape given by ELLIOTT and LOUDON (Sect. 5.2). The Faraday rotation is also influenced by such exciton effects through the dispersion relation

$$\Theta = -\frac{\omega^2 l}{2\pi n}\int\limits_0^\infty \frac{(n_+\alpha_+ - n_-\alpha_-)}{\omega'(\omega'^2-\omega^2)}\,d\omega' \qquad (23.1)$$

and such relation is experimentally illustrated in Fig. 36. The frequency dependence of Faraday rotation also shows reasonable agreement with that expected from discrete exciton transitions. A further interesting observation is that of strong field saturation which is found when rotation is measured as a function of field at the position of the zero-field band edge. This occurs for fields greater than 30 kgauss and is also consistent with a model based on discrete exciton transitions. Effects of strain were also observed. Further measurements at low temperatures of oscillatory Faraday effect in the region of the direct exciton in germanium are given by NISHINA, KOLODZIEJCSAK and LAX[1] and detailed ex-

[1] Y. NISHINA, J. KOLODZIEJCZAK, and B. LAX: Proc. Int. Conf. on Physics of Semiconductors, Paris 1964, p. 867.

pressions for the resonant line shapes as a function of relaxation time τ are given by HALPERN, LAX and NISHINA[1]. For each *exciton* absorption peak the Faraday rotation Θ is given as

$$\Theta_k = A\left\{\frac{X_k+Y_k}{(X_k+Y_k)^2+1} - \frac{X_k-Y_k}{(X_k-Y_k)^2+1}\right\} \tag{23.2}$$

where $X_k=(\omega_k-\omega)\tau_k$, $Y_k=\gamma_k B\tau_k$, A is a constant, ω is the photon frequency, ω_k the frequency of an exciton in state k and γ_k is an effective gyromagnetic constant such that $2\hbar\gamma_k=\mu_B g_k$ with g_k the effective g-factor. τ_k is a phenomenological relaxation time; the actual shape observed will depend strongly on the relation between $1/\tau_k$ and the size of the magnetic splitting.

The corresponding expression for the resonant line shape at *Landau* levels is more complicated:

$$\Theta_n = \frac{\omega_c}{4\pi\sqrt{\tau}}\left(\frac{\mu}{\hbar}\right)^{\frac{3}{2}} A\left[\left\{\frac{\sqrt{(X_n+Y_n)^2+1}+X_n+Y_n}{(X_n+Y_n)^2+1}\right\}^{\frac{1}{2}} - \left\{\frac{\sqrt{(X_n-Y_n)^2+1}+X_n-Y_n}{(X_n-Y_n)^2+1}\right\}^{\frac{1}{2}}\right]. \tag{23.3}$$

For germanium, NISHINA et al. fit both Eqs. (23.2) and (23.3) to their Faraday rotation measurements after subtracting background contribution from other levels. They find the better fit for the exciton case, in agreement with the conclusions of MITCHELL and WALLIS.

NISHINA et al. also report measurements of resonant Voigt shift and give corresponding expressions for the line shapes. Studies of resonant line shapes can therefore estimate the extent of exciton and Landau level contributions to the observed effects and, at high fields, combination of rotation $\Theta_{\max}$ and Voigt shift $\delta_{\max}$ at resonance yields

$$\delta_{\max}/\Theta_{\max} = \text{constant}\times\gamma B\tau$$

where $\gamma=(g_c+g_v)\mu_B/2\hbar$ and simple bands are considered. Since γ can be found from appropriate splitting, this gives a method of investigating τ. Apart from its sign sensitivity and hence ability to separate sets of magnetic levels, resonant Faraday rotation also shows greater sensitivity to structure which appears as minor slope changes in magneto-absorption.

β) *Non-resonant low field interband Faraday effect.* Owing to its experimental simplicity this effect has attracted much experimental attention in all types of crystals with transparent regions since the earliest days of magneto-optics. More recently, with the increasing knowledge of the band structure of certain materials the effect has become recognisable as due to the dispersive effects of interband transitions responsible for IMO absorption, but measured in the transparent region below the energy gap. In semiconductors in particular the band structure is sufficiently well known for quantitative theoretical interpretation to be attempted. Consequently the effect has also attracted considerable theoretical interest, possibly more than the effect justifies since it is not a very specific method of probing band structure. Much of the early theory has subsequently proved to be either incorrect or totally inadequate. The subject has been enlivened by a certain amount of controversy, notably between LIDIARD at Reading and LAX at MIT, and despite rapid progress agreement between theory and experiment is still qualitative rather than quantitative.

We will, therefore, in this article begin by reviewing the experimental situation in semiconducting materials with known band structure. Earlier measurements

[1] J. HALPERN, B. LAX, and Y. NISHINA: Phys. Rev. 134, A 140 (1964).

on insulating solids were found to conform quite well to BECQUEREL's formula, Eq. (1.5), but showed variation in the sign of the effect (see RAMASHESHAN and SIVARAMAKRISHNAN[1] for a review).

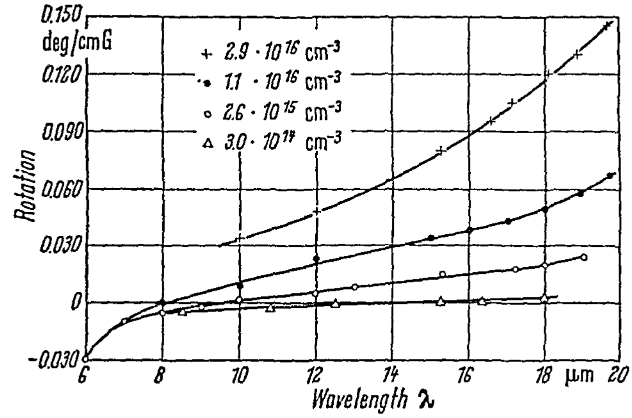

Fig. 37. Interband (negative) and free carrier Faraday rotation in InSb (after SMITH et al.[3]).

The earliest measurements in semiconductors were reported by KIMMEL[2] in 1957 in GaP, Si and InP but were very inadequate, being made with interference filters at a few spot points so that no interpretation was attempted.

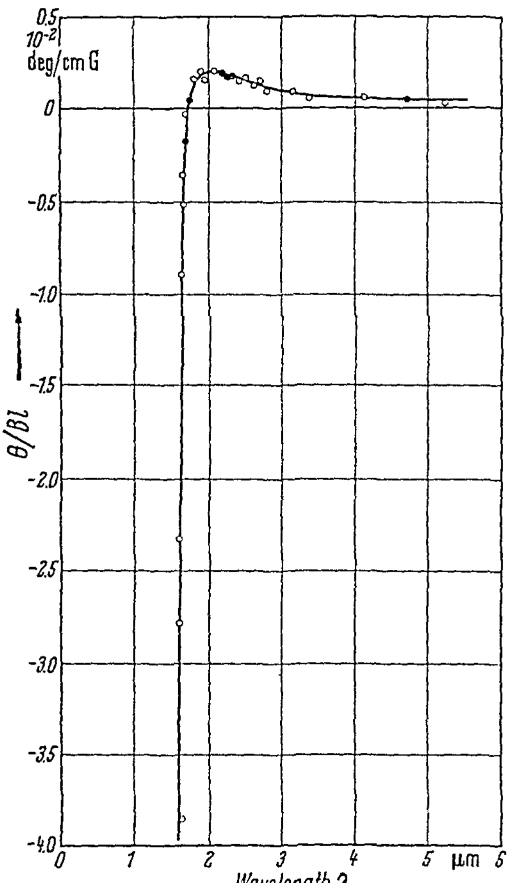

Fig. 38. Interband Faraday rotation in pure germanium (after HARTMANN and KLEMAN, Ref. 2, p. 303).

SMITH, MOSS and TAYLOR (1959) observed the interband effect in InSb[3] (Fig. 37), finding that the interband rotation was of opposite sense to the free electron case. (It is usual to refer to this as negative rotation, most workers taking the free electron effect as positive). They also showed that pure specimens and low temperatures were re-

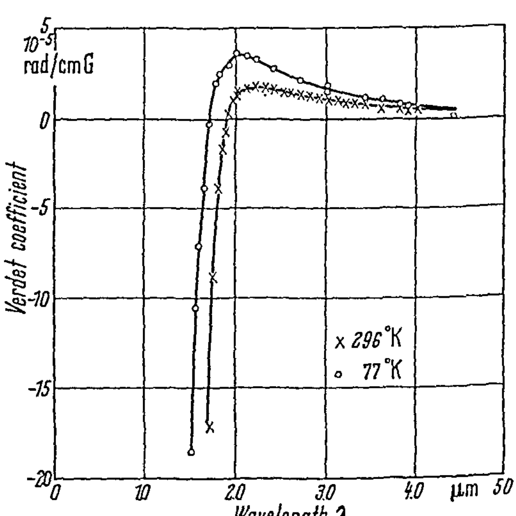

Fig. 39. Interband Faraday rotation in GaSb (after PILLER and PATTON, Ref. 7, p. 303).

[1] S. RAMASHESHAN, and V. SIVARAMAKRISHNAN: Progr. in Crystal Physics 1, 168 (1958).
[2] H. KIMMEL: Z. Naturforsch. 12, 1016 (1957).
[3] S. D. SMITH, T. S. MOSS, and K. W. TAYLOR: J. Phys. Chem. Solids 11, 131 (1959).

quired to separate the interband effect from the relatively large free carrier effect (Fig. 37). This result was independently confirmed by LAX and NISHINA[1] (1959/61) although their published measurements (1960) made with a high free electron concentration did not actually extend to negative rotations, but imply such by their divergence from the λ^2 dependence of the free carrier effect.

The next, and a most interesting observation, was the interband effect in intrinsic germanium (Fig. 38) by HARTMAN and KLEMAN (1960)[2] which shows that although the interband effect is large and negative near the band edge it rises to *positive* values before falling towards zero at long wavelengths. CARDONA (1961)[3] then showed that InAs behaved like InSb, with negative rotation but that GaAs, by contrast gave a positive and apparently monotonically increasing rotation as the band edge was approached.

These results established qualitatively the experimental situation requiring explanation — the existence of positive or negative rotation and, in some materials, of both together with a theory of their frequency dependence. Such effects cannot be obtained from a classical model of a bound electron oscillator and consequently early attempts at interpretation in classical terms are of little value. The early data is also, in most cases, inadequate and more refined measurements have since been made on the materials mentioned above and further materials examined.

For the materials showing negative rotation detailed measurements on pure InSb at 5 and 77° K are given by SMITH, PIDGEON and PROSSER[4] and for InAs 77 and 300 °K by SUMMERS[5]. Further measurements on Ge at 300 and 77° K are given by WALTON and MOSS[6] and PILLER and PATTON[7] and the latter also find that GaSb behaves almost identically to Ge (Fig. 39), giving positive rotation at long waves, changing to negative near the absorption edge.

The materials giving apparently monotonically increasing positive rotation include Si (PILLER and POTTER)[8], InP and GaP[7] but recent measurements on GaAs[9] show that the positive rotation in fact turns over quite near the absorption edge and becomes negative (Fig. 40). In addition to this, GaSb[7] and PbS[9] show a reversal of the sign of interband rotation as a function of the free carrier density while alloys of GaAs and InAs in varying proportion show effects intermediate between the positive and negative effects of the constituent compounds[5].

We now consider the interpretation and theory of the interband effect: this may be approached in a low field limit and at energies far enough below the energy gap to ignore exciton effects. All theories essentially calculate the differential dispersive effect of the transitions responsible for interband magneto-absorption associated with right- and left-circularly polarised radiation. The low field limit may imply that the magnetic splitting is small compared with the line broadening and so the magneto-absorption would be unobservable under these

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[1] R. N. BROWN, and B. LAX: Bull. Am. Phys. Soc. **4**, 133 (1959). — B. LAX, and Y. NISHINA: J. Appl. Phys. Suppl. **32**, 2128 (1961); — Proc. Int. Conf. on Semiconductor Physics, Prague 1960, p. 321.
[2] B. HARTMAN, and B. KLEMAN: Arkiv Fysik **18**, 75 (1960).
[3] M. CARDONA: Phys. Rev. **211**, 756 (1961).
[4] S. D. SMITH, C. R. PIDGEON, and V. PROSSER: Proc. Int. Conf. on Physics of Semiconductors, Exeter 1962, p. 301.
[5] C. J. SUMMERS: To be published.
[6] A. K. WALTON, and T. S. MOSS: Proc. Phys. Soc. (London) **78**, 1393 (1961).
[7] H. PILLER, and V. A. PATTON: Phys. Rev. **129**, 1169 (1963).
[8] H. PILLER, and R. F. POTTER: Phys. Rev. Letters **9**, 203 (1962).
[9] H. PILLER: Proc. Int. Conf. on Physics of Semiconductors, Paris 1964, p. 301.

conditions. As with the free carrier effect, however, the dispersive effect away from resonance is relatively unaffected by line broadening and is observable.

It was noted quite early that the positive and negative rotations could arise from simple Landau levels, including spin [Eqs. (9.13) and (9.14)] if the sum of the effective g-factors, (g_c and g_v) was positive or negative respectively [SMITH and PIDGEON (1960)[1]; CARDONA[2]] the sign of the combined g-factor simply determining the order in energy in which the resonances for r.c.p. or l.c.p. occur.

The earliest attempts to predict frequency dependence were made by LAX and NISHINA (1960, 1961)[3] and SUFFCZYNSKI (1960, 1961)[4]. These authors used a

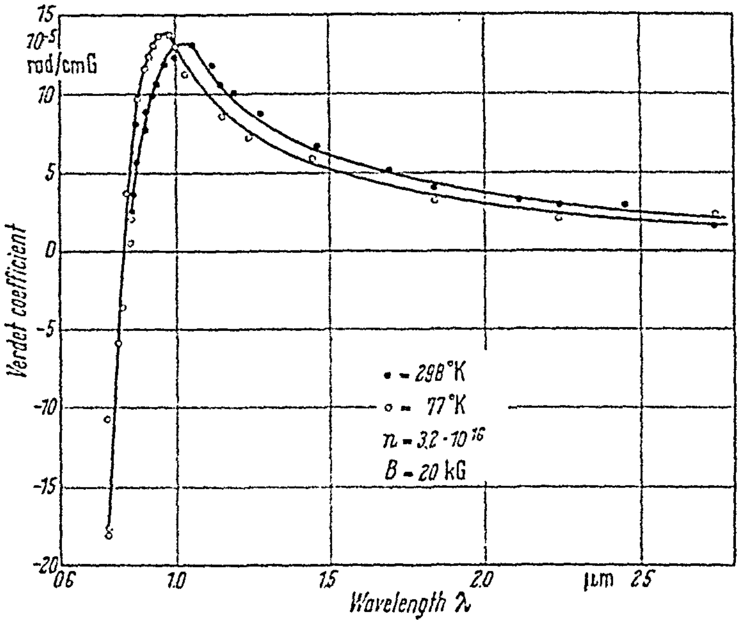

Fig. 40. Interband Faraday rotation in GaAs (after PILLER, Ref. 9, p. 301).

dispersion relation between the real and imaginary parts of the dielectric constant defining the propagation and absorption of circularly polarised modes, i.e., $\varepsilon_\pm$, as defined in Eq. (3.2), i.e.,

$$\varepsilon_\pm = \varepsilon_{xx} \mp i\,\varepsilon_{xy}.$$

The dispersion was then found by substituting $\varepsilon^I_{xx} \mp \varepsilon^R_{xy}$ which characterises the absorption in a single Kramers-Kronig dispersion relation, making analogy with a classical oscillator and hence the Faraday rotation calculated on assumption of simple bands and direct transitions. It was found by LAX and NISHINA to have a leading term of the form

$$\Theta = A\mu^{\frac{3}{2}} |p^x_{cv}|^2\, \gamma\, [\omega^{-1} (\omega_g - \omega)^{-\frac{1}{2}}] \tag{23.4}$$

where A is a constant, μ is the reduced mass and γ contains the effective g-factor ($g_c + g_v$). This leading term in fact describes the rotation near the edge in, for example, InSb quite well but diverges at lower energies. The important constant γ was left to be determined empirically. LAX and NISHINA also considered indirect

[1] S. D. SMITH, and C. R. PIDGEON: Proc. Int. Conf. on Semiconductor Physics, Prague 1960.

[2] M. CARDONA: Phys. Rev. 121, 156 (1961).

[3] B. LAX, and Y. NISHINA: Proc. Int. Conf. on Physics of Semiconductors, Prague 1960; — J. Appl. Phys. 32 (Suppl.) 2128 (1961).

[4] M. SUFFCZYNSKI: Proc. Phys. Soc. (London) 78, 1393 (1961).

transitions and attributed the positive rotation region for Ge to the effects of these transitions.

The problem has been rigorously formulated in macroscopic and quantum mechanical formulae by BOSWARVA, HOWARD and LIDIARD (1962)[1] who showed that there was an error in the use of the Kramers-Kronig relations by both LAX and NISHINA, and, SUFFCZYNSKI. This arises as the real and imaginary parts of the quantity $\varepsilon_\pm$ are asymetric in dispersion relations and separate consideration has to be given to the tensor components ε_{xx} and ε_{xy} through Eqs. (7.1) and (7.2). This error is recognised in later publications of the M.I.T. authors[2]; it gives rise to an incorrect low frequency behaviour but leaves the leading term, as quoted in Eq. (23.4), unchanged.

BOSWARVA et al. develop quantum mechanical formulae for the dielectric constant tensor using time dependent perturbation theory. In the Bloch approximation the Hamiltonian is, including spin-orbit interaction and magnetic field effects, of the form

$$\mathscr{H}=\frac{1}{2m}(\boldsymbol{p}+e\boldsymbol{A})^2+V(\boldsymbol{r})+\frac{1}{2m^2}(\boldsymbol{S}\times\nabla V)\cdot(\boldsymbol{p}+e\boldsymbol{A})+\frac{e}{m}(\boldsymbol{S}\cdot B)$$

where $V(\boldsymbol{r})$ is the one-electron potential, $\boldsymbol{S}$ the spin operator and $\boldsymbol{B}$ the external magnetic induction of vector potential $\boldsymbol{A}$. m is the free electron mass. BHL define an electron velocity operator

$$\boldsymbol{v}=\frac{1}{m}(\boldsymbol{p}+e\boldsymbol{A})+\frac{1}{2m^2}(\boldsymbol{S}\times\nabla V).$$

The interaction with the radiation field is then of the form

$$e\sum_\nu v^{(\nu)}\cdot\boldsymbol{A}'$$

where $\boldsymbol{A}'$ is the vector potential of the radiation and

$$\boldsymbol{A}'=\left(\frac{1}{\omega}\right)\boldsymbol{E}_0\exp i(\omega t-\boldsymbol{k}\cdot\boldsymbol{r})+\text{conj}.$$

in terms of the electric field.

HALPERN, LAX and NISHINA (1964)[3] (HLN) also give a quantum mechanical theory in which they define a momentum operator $\boldsymbol{P}$ from

$$\boldsymbol{P}=\boldsymbol{p}+e\boldsymbol{A}+\frac{1}{2m'}(\boldsymbol{S}\times\nabla V). \tag{23.5}$$

The usual methods of time-dependent perturbation theory then lead BHL to

$$\left.\begin{aligned}\varepsilon_{ij}=\delta_{ij}&-\frac{e^2}{\hbar\omega\varepsilon_0}\sum_k^0\sum_{k'}^u\frac{1}{\omega_{k'k}}\left(\frac{(v_i)_{kk'}(v_j)_{k'k}}{\omega+\omega_{k'k}}-\frac{(V_j)_{kk'}(V_i)_{k'k}}{\omega_{k'k}-\omega}\right)-\\&-\frac{ie^2}{\hbar\omega\varepsilon_0}\sum_k^0\sum_{k'}^u\frac{1}{\omega_{k'k}}\big((V_i)_{kk'}(v_j)_{k'k}\,\delta(\omega+\omega_{k'k})+\\&+(v_j)_{kk'}(v_i)_{k'k}\,\delta(\omega_{kk'}-\omega)\big).\end{aligned}\right\} \tag{23.6}$$

The summation k is over all occupied states and k' over all unoccupied states. The last term in (23.6) determines the energy absorption; the velocity operator

[1] I. M. BOSWARVA, R. E. HOWARD, and A. B. LIDIARD: Proc. Roy. Soc. (London) A 269, 125 (1962).

[2] J. KOLODZIEJCZAK, B. LAX, and Y. NISHINA: Phys. Rev. 128, 2655 (1962).

[3] J. HALPERN, B. LAX, and Y. NISHINA: Phys. Rev. 134, A 140 (1964).

is related to the position operator by

$$(v)_{k'k} = i\,\omega_{k'k}\,(r)_{k'k}$$

and on substituting this, the second term gives the Kramers-Heisenberg dispersion formula. In solids, with periodic wave functions however it is more convenient to formulate in velocity matrix elements. Calculating the component ε_{xy} from (23.6) and noting that in a cubic crystal $\varepsilon_{xy} = -\varepsilon_{yx}$ BHL find the Faraday rotation from Eq. (5.5) as

$$\Theta = -\frac{i e^2}{2 n \hbar \varepsilon_0 c} \sum_k \sum_{k'} \frac{(V_x)_{kk'}(v_y)_{k'k} - (v_y)_{kk'}(v_x)_{k'k}}{\omega_{k'k'}^2 - \omega^2}$$

in m.k.s. units. The δ-function terms in (23.6) have been neglected for Θ at frequencies well away from the allowed transitions. This result can be generally applied to various band models and can be written in terms of the velocity matrix elements for right and left circularly polarised radiation as

$$\Theta = \frac{-e^2}{4 n \hbar \varepsilon_0 c} \sum_k^0 \sum_{k'}^u \left\{ \frac{\omega^2}{\omega_{k'k}^2} \left[\frac{|v_{k'k}(+)|^2 - |v_{k'k}(-)|^2}{\omega_{k'k}^2 - \omega^2} \right] \right\} \tag{23.7}$$

in which use is made of a sum rule on the matrix elements v_x and v_y. This form predicts that as $\omega \to 0$, $\Theta \propto \omega^2$ which fact was known by Verdet 100 years ago. The denominators containing the term $(\omega_{k'k}^2 - \omega^2)$ ensure that the allowed transitions close to the absorption edge dominate the non-resonant rotation, particularly near the absorption edge. BHL calculate Θ for simple bands [Eqs. (9.13) and (9.14)], making the assumption that $v(+) \doteq v(-)$, obtaining

$$\Theta = \frac{\sqrt{2}\, e^2 \mu^{\frac{3}{2}} |p_{cv}^x|^2 \gamma B}{4 \pi m^2 \hbar^{\frac{5}{2}} n c \varepsilon_0} \left[\omega^{-1}(\omega_g - \omega)^{-\frac{1}{2}} - \omega^{-1}(\omega_g + \omega)^{\frac{1}{2}} - \omega_g^{-\frac{3}{2}}\right]. \tag{23.8}$$

This expression agrees in its leading term with the incorrect one of LAX and NISHINA. LAX, however, has criticised the assumption that $v(+) = v(-)$ was an adequate approximation for the necessary summations, since $v(+)$ and $v(-)$ are field dependent quantities. It should be noted however that the frequency dependence of interband rotation in InSb in the range $\frac{3}{4}\omega_g$ to $\frac{1}{4}\omega_g$ was found experimentally by SMITH, PIDGEON and PROSSER (Fig. 41) to agree very well with Eq. (23.8). The BHL model does not however provide a basis for predicting the relative signs and magnitude of rotation in different materials.

In a second paper, BOSWARVA and LIDIARD[1] (BL) take into account the field dependence of the velocity matrix elements from Eq. (11.3) and adopt a more realistic band model by using the Luttinger-Kohn expressions for the degenerate valence states. Machine computations of the sums indicated in Eq. (23.7) are made for the cases of GaAs, GaSb, Ge, InAs and InSb, using experimental values for the energy gaps and conduction and valence band parameters.

The main physical conclusions can be easily stated: inclusion of the degenerate valence band gives rise to transitions arising from light hole heavy hole levels which give contributions to the Faraday rotation of opposite sign. This competition allows the possibility of both signs and also that the rotation can pass through a positive maximum and then become negative near the edge as occurs so prominently in Ge and GaSb. Thus the model, invoking only band edge wave functions and direct transitions gives the first qualitatively satisfactory explanation of the observation on interband Faraday effect. The calculation is too complicated to quote formulae and the results are therefore presented in Figs. 42a

[1] I. M. BOSWARVA, and A. B. LIDIARD: Proc. Roy. Soc. (London) A 278, 588 (1964).

to c. It may be noticed that quantitative agreement is still not very satisfactory. This is not surprising considering that two relatively large terms of opposite sign must be calculated and small errors will be magnified on taking the difference. Damping is not included; recent calculations and measurements on InAs by BOSWARVA and SUMMERS[1] including damping have given the best quantitative agreement to date (Fig. 43).

It would seem, therefore, that the main effects can be accounted for by direct transitions near the zone centre. However, deeper lying transitions give rise to

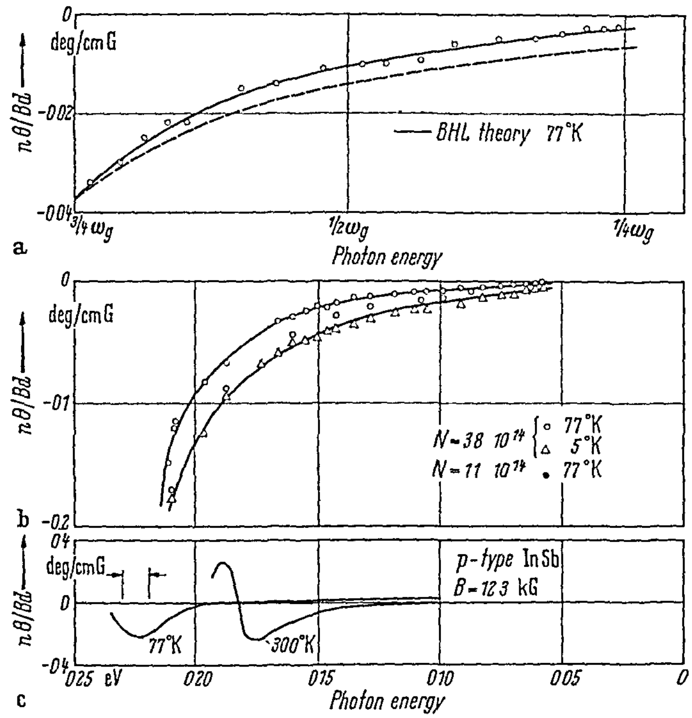

Fig. 41. (a) Comparison with theory of interband Faraday rotation for InSb ($N=3.8\times10^{14}$ cm^{-3}, $T=77°$ K). (b) Interband rotation as function of temperature and impurity for n-type material. (c) As (b) for p-type material (after SMITH et al., Ref. 4, p. 303).

very intense absorption due to the larger number of states available and may give significant contributions to the Faraday rotation as may be estimated from the Kramers-Kronig relations in the form of Eq. (7.5). The BL model of parabolic bands does not sensibly apply to deep levels. These workers estimate that, with reasonable parameters for the gyromagnetic splitting, transitions near the L-point (~2.0 eV) make some contribution in large gap materials such as Ge, GaAs, and GaSb but suggest that it is qualitatively unimportant. An earlier paper considering these transitions is in error both qualitatively and quantitatively[2]. Experimental results tend to support the conclusions that the zone centre transitions dominate since effects of filling the conduction and valence bands and changing the composition of alloys of GaAs and InAs can produce profound effects on the interband rotation. Effects of strain are rather inconclusive[3].

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[1] C. J. SUMMERS, and I. M. BOSWARVA: To be published.

[2] I. M. BOSWARVA, and A. B. LIDIARD: Proc. Int. Conf. on Physics of Semiconductors, Exeter 1962, p. 308.

[3] C. R. PIDGEON, C. J. SUMMERS, T. ARAI, and S. D. SMITH: Proc. Int. Conf. on Physics of Semiconductors, Paris, 1964, p. 289.

A systematic trend is predicted in that small band gap materials (e.g., InAs, InSb) will have small valence band masses and hence a favoured light hole (negative) contribution to Θ, in agreement with experiment. The overall agreement and use of Eq. (7.5) seem to rule out the theory put forward by LAX and

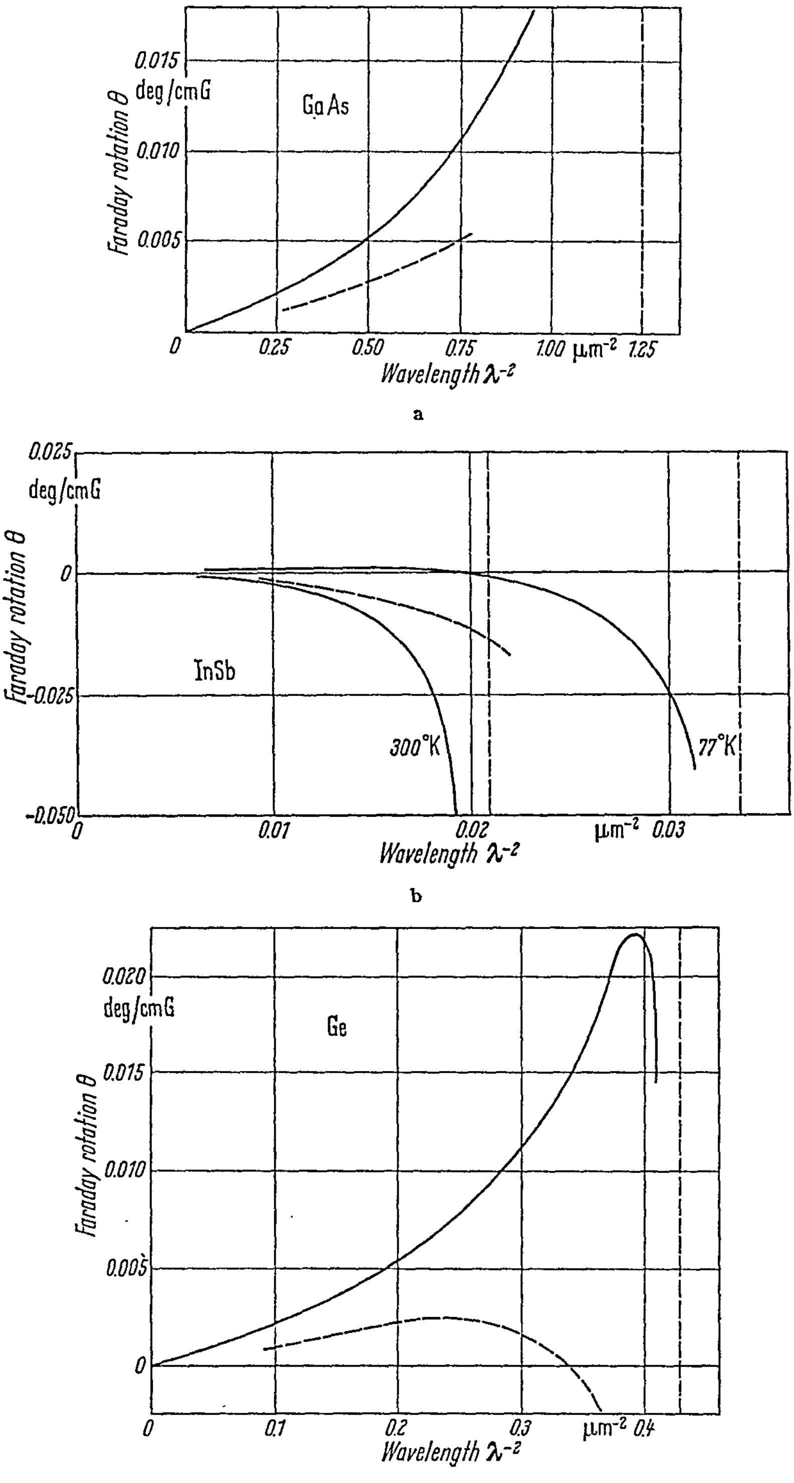

Fig. 42a—c. Comparison of theory (full line) with experiment (dashed) for (a) GaAs; (b) InSb; (c) Ge (after BOSWARVA and LIDIARD, Ref. 1, p. 306). The vertical dashed line is drawn at the position of the energy gap.

NISHINA that indirect transitions are responsible for the positive effects and used by several experimenters in interpretating measurements on Ge and GaSb.

The same problem has also been treated by ROTH[1] and by BENNETT and STERN[2]. ROTH uses a modified Bloch representation and a different formalism. She applies the results to similar band models as BL but fails to predict positive rotation for GaAs although her theory suggests that large gaps favour positive rotation.

There exist, in the published literature, discrepancies over the velocity matrix elements (but now changed from that stated by LAX[3]). HALPERN, LAX

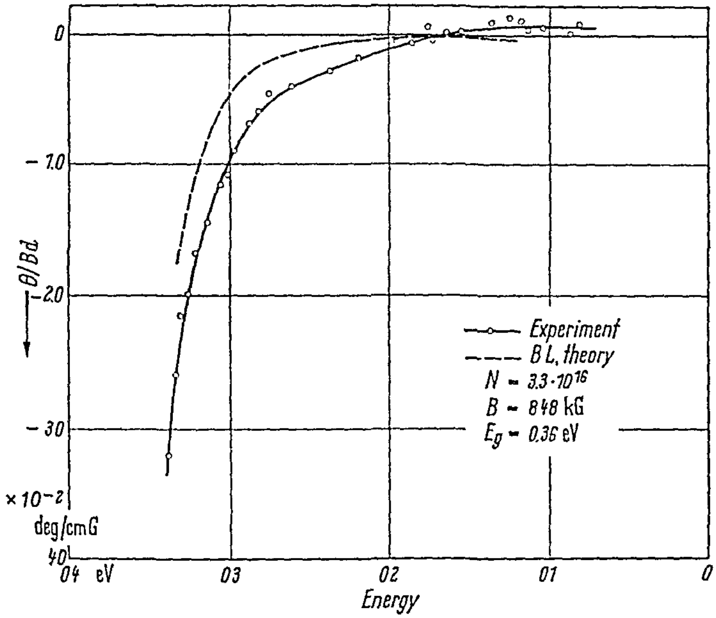

Fig. 43. Interband Faraday rotation in InAs compared with theory (after SUMMERS and BOSWARVA, Ref. 1, p. 307).

and NISHINA express the Faraday rotation in terms of the momentum matrix element $P_{kk'}$ as defined in Eq. (23.5) as follows:

$$\Theta = A \sum_k \sum_{k'} \frac{|P_{kk'}^+|^2}{(\omega_{kk'}^+)^2 - \omega^2} - \frac{|P_{kk'}^-|^2}{(\omega_{kk'}^-)^2 - \omega^2}$$

where A is a constant, giving a different denominator to each of the sets of transitions. Since $\Theta \to 0$ as $\omega \to 0$ it follows that

$$\sum_k \sum_{k'} \frac{|P_{kk'}^+|^2}{(\omega_{kk'}^+)^2} = \sum_k \sum_{k'} \frac{|P_{kk'}^-|^2}{(\omega_{kk'}^-)^2}$$

and they argue further that this equality holds for *each* pair of transitions kk', i.e.,

$$\frac{P_{kk'}^+}{\omega_{kk'}^+} = \frac{P_{kk'}^-}{\omega_{kk'}^-} \tag{23.9}$$

on the basis that the levels are discrete, and equivalent to a classical oscillator so that the correspondence principle applies. This is at variance with results of BL who state that the matrix elements are given by Eq. (11.3). The result (23.9) can be obtained from (11.3) as follows: the velocity matrix elements contain the

[1] L. M. ROTH: Phys. Rev. **133**, A 542 (1964).
[2] H. S. BENNETT, and E. A. STERN: Phys. Rev. **137**, A 448 (1965).
[3] B. LAX: Proc. Int. Conf. on Physics of Semiconductors, Paris 1964, p. 253.

factor $(1 \pm \omega_c/\omega_{kk'})$ where $\omega_c = \frac{eB}{m}$ and m is the free mass of the electron. It is then necessary to assume that the transition frequencies have a gyromagnetic splitting of $\pm\omega_c$ for the HLN equality to hold. This splitting is, of course $\pm\gamma B$ where $\gamma = (g_c + g_v)\beta$ and the g-factors are anomalous so the HLN result is contrary to the magnetic field dependence of the matrix elements as given by ELLIOTT, MCLEAN and MACFARLANE.

BENNET and STERN (1965) give a discussion of the elements of the complex conductivity tensor responsible for the Faraday rotation (i.e. $\sigma_{xy}^{(R)}$) which in an earlier form provided some of the basis for the BHL treatment, but they discuss the effect of the field dependence of the matrix elements more completely. They obtain the following results [from (23.6)]:

$$\sigma_{xy}^{(R)} = \text{Constant} \times \sum_k \sum_{k'} \left\{ \left[\frac{2|\langle k|\pi^-|k'\rangle|^2 \omega_{kk'}^{-2}}{(\omega_{kk'}^- - \omega^2)^2} \frac{\partial \omega_{kk'}^-}{\partial B} - \right. \right. \\ \left. \left. - \frac{1}{(\omega_{kk'}^- - \omega^2)} \frac{\partial}{\partial B} |\langle k|\pi^-|k'\rangle|^2 \right] \right\} \tag{23.10}$$

and corresponding terms with R.C.P. Selection rules. The operator π includes a spin term, i.e.

$$\pi = (p + eA) + \frac{\hbar}{4m} (\sigma \times \nabla V(r)). \tag{23.11}$$

The expression (23.10) shows clearly that the field dependence of the matrix elements influence the Faraday rotation in addition to level splitting. Using the BHL expression for the matrix elements from Eq. (11.3), we note that V_+ and V_- differ by about 1 part in 10^4 for fields around 10,000 gauss. The matrix element change will therefore only become important at frequencies removed from the transition frequency such that $\omega_{kk'} - \omega$ is around 10^4 times $(\omega_{kk'}^+ - \omega_{kk'}^-)$, the magnetic splitting frequency, when considering the same value of applied field. In practice for semiconductors this applies only to frequencies very close to zero and so only affects the zero field limit for interband effects. BENNETT and STERN note that the expansion leading to Eq. (11.3) is made only to 1st order in (a/R), where a is a lattice constant and R the orbit radius [Eq. (9.10)], and, when including the spin orbit term [Eq. (23.11)] and expanding further they find that terms in $(a/R)^2$ make contributions of equal magnitude. When applied to a non-degenerate band model their calculation gives a correct zero frequency limit and in this respect is more satisfactory than the treatment of BOSWARVA and LIDIARD. The Roth treatment also illustrates the dual contribution of level splitting matrix elements and considers the effects of degenerate bands. Neither treatment supports the HLN equality for each pair of levels.

It should be noted however that in the experimentally significant region for non-resonant Faraday effect — say from ω_g to $\frac{1}{4}\omega_g$ the matrix element term has little effect and the main conclusions of BOSWARVA and LIDIARD concerning the competition of light and heavy hole states appears to stand. Similarly, the main results of HLN for resonant Faraday and Voigt effects [Eqs. (23.2), (23.3) etc.] are essentially unaffected. Contributions from the matrix elements of very deep lying levels may have a small effect in both cases.

Relevant to the low frequency limit is a recent result of MITCHELL, PALIK and WALLIS[1], who find that the effect of populating the conduction band of PbS with electrons is to change the *inter-band* rotation in such a way that a non-zero low frequency limit is implied.

[1] D. L. MITCHELL, E. D. PALIK, and R. F. WALLIS: Phys. Rev. Letters 14, 827 (1965).

Very recently new results on interband Faraday rotation have been reported for ZnO, ZnS, ZnSe, ZnTe, CdS and CdTe at room temperature and 107° K[1]. All give positive effects.

24. Interband magneto-reflection. Resonant interband effects can be observed in reflection as well as transmission. Since the reflectivity depends upon both n and κ from Eqs. (15.13) and (15.14) complete separation of absorptive and dispersive effects is not always possible in this type of measurement. However, even for high absorption, n is usually greater than κ and thus magneto-reflection at resonance has much in common with resonant interband Faraday effect in its dependence upon optical constants. We can write

$$R = 1 - \frac{4n}{(n+1)^2 + \kappa^2},$$

$$\Delta R = \frac{4(n^2 - \kappa^2 - 1)\,\Delta n + 8 n \kappa \Delta \kappa}{[(n+1)^2 + \kappa^2]^2}$$

where changes Δn and $\Delta \kappa$ are introduced by the magnetic field. If $\kappa \ll n$, $\Delta R \sim \Delta n$, but typical values may be $n \sim 4$, $\kappa \sim 2$. As is common, the experiment was first pioneered using InSb, by WRIGHT and LAX (1961)[2]. A maximum charge in R of around 10% was obtained on applying the field. The positions of the Landau levels were readily distinguished and the results enabled the usual convergence plots to be made from which energy gaps, effective masses and g-factors could be deduced.

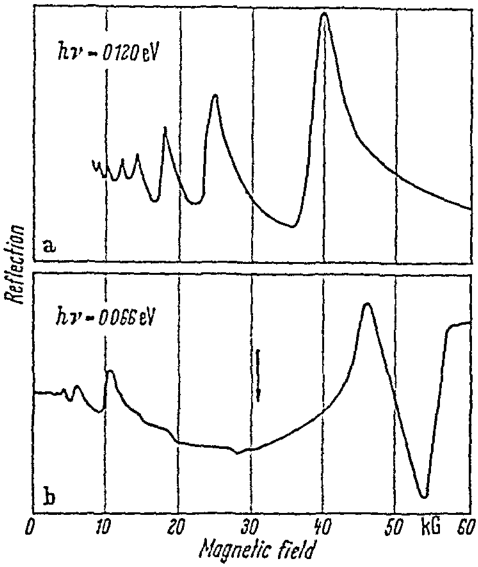

Fig. 44 a and b. Magneto reflection from Bismuth at 4.2° K as a function of magnetic field. (a) is at a photon energy of 0.120 eV, and (b) is at 0.066 eV (after BROWN et al., Ref. 3, p. 311).

The particular application of interband reflection techniques (IMR) is to materials having no region of transparency, such as bismuth and graphite. It is not necessary to construct very thin specimens, thus avoiding experimental difficulties and strain effects when using IMR techniques although care must be taken to ensure that the surface is typical of the bulk crystal in structure.

Interesting results have been obtained for bismuth by BROWN, MAVROIDES and LAX[3] (Fig. 44). The peaks (taken at 0.12 eV) can be fitted to a non-quadratic two-band model given by

$$\varepsilon_n\left(1 + \frac{\varepsilon_n}{\varepsilon_g}\right) = \left(n + \frac{1}{2}\right)\hbar\,\omega \pm g_c \mu_B B$$

with $m_1^* = 0.0021$ and $m_2^* = 0.0046$ for values of an anisotropic conduction band mass and $\varepsilon_g = 0.015$ eV.

For graphite[4] two series of reflection peaks are obtained. These are associated with two different interband transitions at different points of the Brillouin zone. Quantitative interpretation in terms of non-parabolic bands is again possible.

[1] A. EBINA, T. KODA, and S. SHIONOYA: J. Phys. Chem. Solids 26, 1497 (1965) and M. BALKANSKI, E. AMZALLAG, and D. LANGER: J. Phys. Chem. Solids 27, 299 (1966).

[2] G. B. WRIGHT, and B. LAX: J. Appl. Phys., Suppl. 32, 2113 (1961).

[3] R. N. BROWN, J. G. MAVROIDES, and B. LAX: Phys. Rev. 129, 2055 (1963).

[4] M. S. DRESSELHAUS, and J. G. MAVROIDES: See B. LAX, Proc. Int. Conf. on Semiconductor Physics, 1964, p. 253.

Interband magneto-polarimetric effects in rotation have been observed by LAX and NISHINA[1] on InSb and by GOBRECHT, TAUSEND and HERTEL[2] with selenium.

25. Cross-field magneto absorption. Interband resonant effects in the simultaneous presence of magnetic and electric fields have been investigated theoretically by ARONOV[3] and experimentally by VREHEN and LAX[4]. Aronov originally suggested that fields around 10^4 V/cm and 100 kgauss would be required. In practice effects are observable using oscillating electric fields in the range 200 to 500 v/cm and magnetic fields ~ 25 kgauss. The basic cross field effect consists

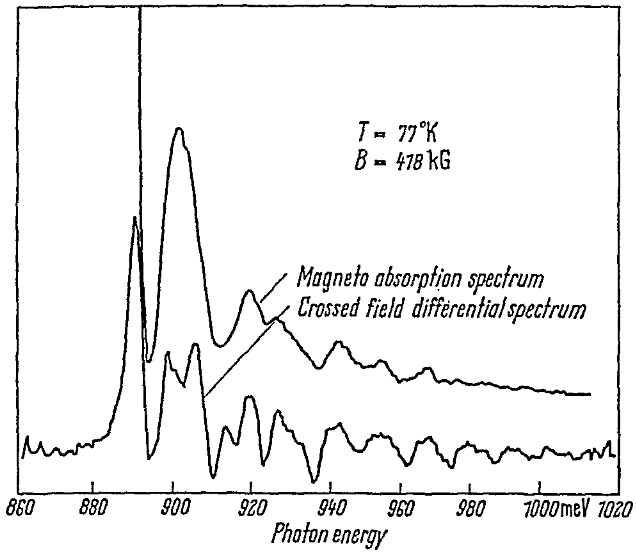

Fig. 45. (a) IMO spectrum of germanium at $B=41.8$ kgauss and zero electric field. (b) Differential cross-field absorption at second harmonic (i.e., 1400 cps) at same value of B, and $E=500$ volts per cm. "Positive" and "Negative" lines occur (after VREHEN and LAX, Ref. 4, p. 312).

of two parts: (i) a modification of the energies of Landau levels so that the energy separation between valence and conduction bands is given by ARONOV's analysis is

$$\Delta\varepsilon_{n n'} = E_G + \left(n + \frac{1}{2}\right)\hbar\,\omega_{cc} + \left(n' + \frac{1}{2}\right)\hbar\,\omega_{cv} - \frac{E^2}{2B^2}\,(m_c + m_v)$$

although the expression does not give a realistic low field limit, and (ii) modification to the matrix elements so that the previously forbidden transitions $\Delta n = \pm 1$, ± 2, become allowed. This enables the effective masses of electrons and holes to be determined separately, rather than the reduced mass. A comparison between the magneto absorption and the differential cross field absorption as observed in germanium is shown in Fig. 45. Both positive (increased absorption) and negative (decreased absorption) lines were found, the latter corresponding to coincide with normally allowed transitions.

26. Emission from semiconductor diodes in a magnetic field. Semiconductor diodes as radiation sources have become of great interest since the discovery of laser action in the GaAs diode. The effect of a magnetic field upon an InSb diode, emitting non-coherently, was reported by BENOIT À LA GUILLAUME and LAVAL-

[1] B. LAX, and Y. NISHINA: J. Appl. Phys. (Suppl.) 32, 2128 (1961).
[2] H. GOBRECHT, A. TAUSEND, and J. HERTEL: Z. Physik 178, 19 (1964).
[3] A. G. ARONOV: Soviet Physics — Solid State 5, 402 (1963).
[4] Q. H. F. VREHEN, and B. LAX: Phys. Rev. Letters 12, 471 (1964).

LARD[1], line splitting and shifting associated with the Landau levels being observed. This observation has been extended to stimulated emission from both InSb[2] and GaAs[3] diodes and provides a method of timing the frequency of the emission (Fig. 46). A further important result is that the threshold currenct for laser action

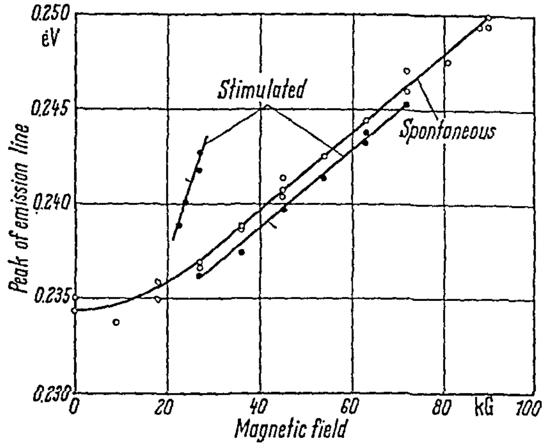

Fig. 46. Emission of InSb diode and laser as a function of magnetic field (after REDIKER and PHELAN, Ref. 2, p. 313).

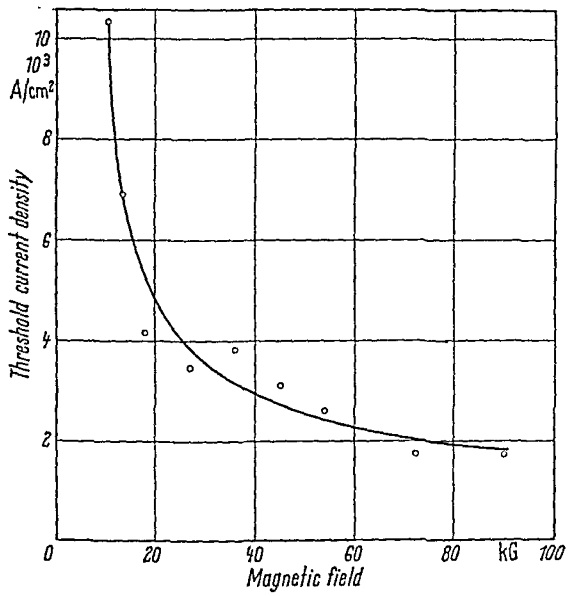

Fig. 47. Threshold current density for laser action as a function of magnetic field for InSb laser at 1.7° K (after REDIKER and PHELAN, Ref. 2, p. 313).

is greatly reduced in a magnetic field (Fig. 47). Magneto-dispersive effects on the refractive index also have effect upon the interferometric modes of the crystal étalon which shift in frequency. In the GaAs case[3], energy shifts of emission lines are found to vary quadratically with field, suggesting that the transitions proceed through the ground states of donors (see Sect. 27).

[1] C. BENOIT À LA GUILLAUME, and P. LAVALLARD: Proc. Int. Conf. on Physics of Semiconductors, Exeter, 1962, p. 875.
[2] R. H. REDIKER, and R. J. PHELAN: Proc. I.E.E.E. 52, 91 (1964).
[3] F. L. GALEENER, et al.: Phys. Rev. Letters 10, 472 (1964).

Various schemes for the generation of far infra-red radiation by exciting stimulated emission from the cyclotron-resonance transitions have been proposed. Optical pumping between interband Landau levels in InSb using He-Ne maser at 3.1 μ or InAs at 3.5 μ has been suggested which together with a field of 100 kgauss is said to have the possibility of inverting the population of the $n=2$ and $n=1$ levels and so giving emission at about 30 μ. Alternatively, JAVEN has suggested optical pumping at two frequencies differing by $\hbar\,\omega_c$[1].

VI. Impurities and magnetic materials.

27. Impurity magneto-optic effects. The simplest model for the energy states associated with impurities is that of the hydrogen atom with an electron which has an isotropic effective mass m^* and with the nuclear charge reduced by e/ε where ε is the high frequency dielectric constant of the crystal. This leads to a hydrogen-like series of energy levels leading up to a photo-ionisation continuum commencing at an energy such that the electron (or hole) is excited into the conduction (or valence) band.

Application of a magnetic field gives rise to two optical effects — (i) a Zeeman effect for the transitions between ground and excited states directly analogous to that in the free atom and (ii) an impurity photo-ionisation magneto-optic effect.

The low-field theory of the Zeeman effect is well known — linear and quadratic effects are obtained; the energy shift for the quadratic effect may be written

$$\Delta\varepsilon = \left\{\frac{\hbar^2 e^2/m^2}{13.6}\right\}\frac{\varepsilon^2}{(m^*/m)^3}\,\frac{B^2}{8}$$

in the hydrogenic-effective mass approximation. Due to the dependence upon m^* and ε, this splitting can readily reach a very high field limit in semiconductors where the usual theory does not apply. Such a situation has been studied by YAFET, KEYES and ADAMS[2]. An important consequence is that the ionisation energy of the impurity increases as the magnetic field increases.

The theory of the photo-ionisation effect has been considered by WALLIS and BOWLDEN[3]. Since impurity ionisation energies can be very small two cases can be distinguished: when the ionisation energy (E_I) is greater or less than $\frac{1}{2}\hbar\,\omega_c$ — the change in energy gap. In the low case $(E_I > \frac{1}{2}\hbar\,\omega_c)$ the spectrum consists of a series of oscillations, assuming that the ground state of the impurity is unaffected by the magnetic field and that the band Landau states are unaffected by the impurity potential. The oscillations are just those of the band Landau levels in such a case, with separation $\hbar\,\omega$ and commencing when $\hbar\,\omega = E_I$.

The observation of Zeeman splitting of impurity levels in germanium has been reported in 1958 by FAN and FISHER[4] and BOYLE[5] for arsenic and phosphorus impurities. In germanium, the energy surfaces for electrons are, of course, ellipsoids and thus the situation is more complicated than the isotropic hydrogenic case. However, both investigators used magnetic fields in (100) directions which is symmetric with respect to ⟨111⟩ oriented ellipsoids leaving the Landau levels in the four valleys degenerate and the simplest situation for the band state splitting. Results are shown in Fig. 48 — a linear shift being observed. Values for the transverse mass were obtained, in agreement with other experiments. BOYLE'S

[1] See B. LAX, Proc. Int. Conf. on Physics of Semiconductors, Paris, 1964, p. 258.
[2] Y. YAFET, R. W. KEYES, and E. N. ADAMS: J. Phys. Chem. Solids 1, 137 (1956).
[3] R. F. WALLIS, and H. J. BOWLDEN: J. Phys. Chem. Solids 7, 78 (1958); 9, 318 (1959).
[4] H. Y. FAN, and P. FISHER: J. Phys. Chem. Solids 8, 270 (1959).
[5] W. BOYLE: J. Phys. Chem. Solids 8, 321 (1959).

results also showed the photo-ionisation oscillatory effect. Zeeman spectra of both n- and p-type silicon have been studied by ZWERDLING, BUTTON and LAX[1] and the linear and quadratic effects separated.

The change of ionisation energy in a magnetic field has been demonstrated in InSb, for example in the photoconductive detector described by PUTLEY[2]. Zeeman effects from impurity levels associated with the "split-off" valence band in silicon, called internal impurity levels, have been observed in boron doped silicon and the spin orbit splitting (0.0442 eV) deduced[3].

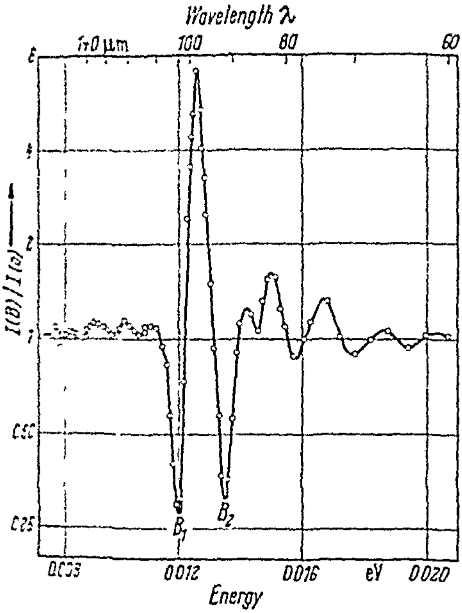

Fig. 48.

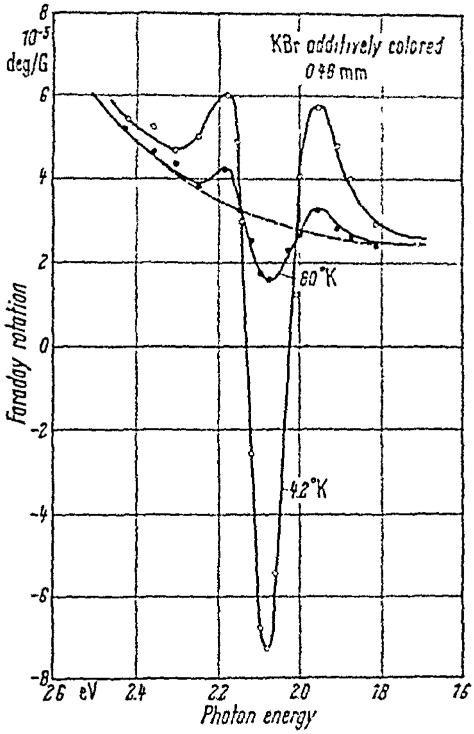

Fig. 49.

Fig. 48. Zeeman splitting of the impurity line of boron in Silicon (after FAN and FISHER, Ref. 4, p. 314).

Fig. 49. Faraday rotation through the F band in KBr (7.8×10^{16} F centres per cc and with a field of 50k gauss giving a maximum rotation of 5° at Helium temperatures; after MORT et al., Ref. 4, p. 315).

Faraday rotation has been observed at frequencies passing through the absorption resonance of the F-centre (i.e. an electron trapped at a negative ion vacancy) in alkali halide crystals[4]. This is a beautiful example of the greater sensitivity of the Faraday effect since the Zeeman splitting is $\sim 10^{-4}$ eV and with the F-band width ~ 0.2 eV the primary absorption effect would be very difficult to observe. Nevertheless well defined Faraday rotations were observed (Fig. 49) in KCl, NaCl, KBr, KI, RbBr and CsBr.

The results are interpreted in this of the electronic structure of the F-centre including spin orbit splitting.

28. Magnetic materials. We have concentrated in this review upon systems, which due to their simplicity, have enabled considerable progress to be made in the understanding of magneto-optical effects during the past ten years. For ferro-

[1] S. ZWERDLING, K. BUTTON, and B. LAX: Phys. Rev. 118, 975 (1960).
[2] E. PUTLEY: J. Phys. Chem. Solids 22, 241 (1961).
[3] S. ZWERDLING, et al.: Phys. Rev. Letters 4, 173 (1960).
[4] J. MORT, F. LÜTY, and F. C. BROWN: Phys. Rev. 137, A 566 (1965).

magnetic materials, by contrast, the effects on the state of polarisation of both transmitted (Faraday effect) and reflected (Kerr magneto-optic effect) radiation have been known since the last century. Experiments show that the effects are proportional to the net magnetisation of the sample and not to the external field. In terms of *external* applied fields the magnitude of the effects are also vastly greater in ferromagnetic material (e.g. 2° per cm in 10 Kilogauss in quartz compared with 380,000° per cm in iron under the same conditions). Such magnitudes require the presence of internal fields of around 10^6—10^7 gauss, comparable with the postulates of the Weiss field explanation of ferromagnetic materials. A theoretical account of Faraday and Kerr effects in 'metallic' ferromagnetics has been given by ARGYRES[1] using band theory concepts. He points out that the Weiss field cannot affect the motion of electrons as an equivalent field and that spin orbit interaction, introduced to the problem by HULME, is required to explain the optical effects. The theory is developed and shows why this interaction is operative only in ferromagnets and is found to be in reasonable agreement with experiment. Measurements suffer from the difficulties associated with highly absorbing materials and are almost all of the non-resonant polarimetric type, often on thin evaporated films. Recently, insulating ferromagnets such as CrI_3, $CrBr_3$ and $CrCl_3$ have been investigated[2]. When magnetised they show very large rotations of the order of 2.4×10^5 degrees per cm. CrI_3 has an absorption edge near 1 μ and it would be very interesting to investigate resonant phenomena such as IMO on thin layers of such material.

Antiferromagnetic resonance is a far infra-red or microwave phenomenon in which, with two equal anti-parallel sublattices of spins present, the spins of single ions can turn over against the exchange field and cause a resonance. The frequency of resonance can be used as a method to determine the size of the anisotropy field of a material[3].

VII. Experimental techniques.

29. Standard experimental techniques of generating high magnetic fields, high resolution spectroscopy (mainly in the infra-red) cryogenics and sample preparation are required in magneto-optical studies and it would be inappropriate to review these in detail. Some particular parts concerning each merit some discussion however.

Magnetic fields up to 35 kgauss are usually obtained from iron-core magnets and crystals and specimens are often miniaturised to ensure the smallest possible gap. Fields between 50—250 kgauss usually imply a Bitter-type solenoid with massive subsidiary power and cooling installations and are therefore only available in large laboratories, notably the National Magnet Laboratory at MIT[4] and the Naval Research Laboratory in Washington. Pulsed field techniques have not found general favour. It is worthy of note that the vast majority of experiments have been performed with fields less than (say) 65 kgauss and recent developments in superconducting solenoids have made fields of this size available at a relatively modest cost of a few thousand pounds. An example of such a solenoid specifically designed for magneto-optical work at liquid helium, liquid nitrogen and room temperatures is shown in Fig. 50. This solenoid which gives 66 kgauss using

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[1] P. N. ARGYRES: Phys. Rev. 97, 334 (1955).
[2] J. F. DILLON, and C. E. OLSON: J. App. Phys. 36, 3, 2, 1259 (1965).
[3] R. C. OHLMANN, and M. TINKHAM: Phys. Rev. 123, 425 (1961).
[4] F. BITTER: Brit. J. Appl. Phys. 14, 759 (1963).

niobium-tin wire was developed by the Oxford Instrument Company in conjunction with C. J. SUMMERS at the University of Reading. Improvements in superconducting wire may well raise the practical limit to 100 kgauss within a few years.

Sample preparation development enables single crystals down to a few microns to be prepared; problems of strain in such samples at low temperature cause problems. Magneto-polarimetric experiments have stimulated some developments. Polarisers are still a problem beyond 2μ up to which HR polaroid may be used. Brewster angle stacks of mica polythene and other plastics are commonly used and also reflection from Ge or Si plates but all are unsatisfactory in some ways. Metal wire grids, useful beyond 2μ are a recent development[1]. Measuring techniques can however be quite powerful even in the infra-red — Faraday rotation can be measured to $\sim \frac{1}{200}{}^{\circ}$ [1,2], and ingenious methods of measuring Voigt effects and ellipticity have been devised[2–4].

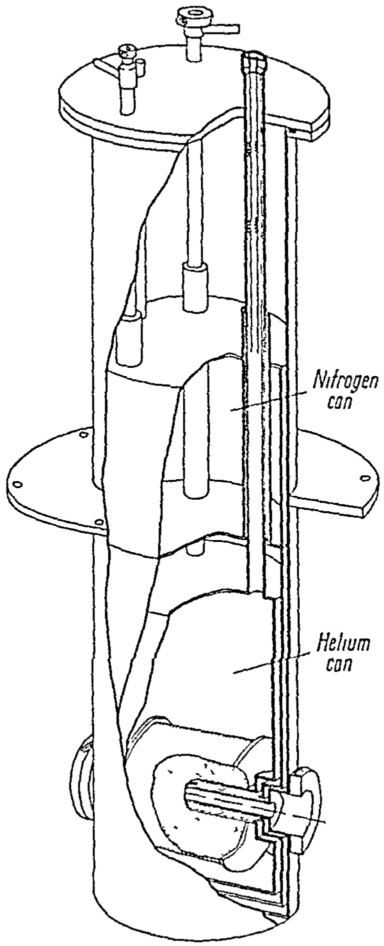

Fig. 50. Superconducting solenoid for magneto-optical experiments, constructed by Oxford Instrument Company for the University of Reading.

VIII. Summary.

30. The enormous expansion of this subject since the crucial resonance experiments in 1956 must be apparent from the number of topics covered in this review. The spread of crystal magneto-optics to semiconductors has enabled quantitative interpretation to be made of many effects in terms of band structure and we have concentrated on such uses. With most of the possible effects now observed we can now reverse the latter statement and say that the purpose of magneto-optical experiments is to explore quantitatively the electronic band structure of semiconductors (and insulators). Thus the subject has a role similar to inelastic neutron scattering and phonon dispersion curves and to oscillatory magnetic susceptibility and energy surfaces in metals. However, the variety of magneto-optic experiments is much greater and each technique is, as yet, rather limited in application as compared with the other two examples cited. We conclude therefore with a list of parameters which it is possible, or desirable, to measure together with what appear at present the most suitable techniques or combination of techniques.

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[1] G. R. BIRD, and M. PERRISH: J. Opt. Soc. Am. 50, 886 (1960).
[2] C. R. PIDGEON, and S. D. SMITH: Infra-red Physics 4, 13 (1964).
[3] D. L. MITCHELL, and R. F. WALLIS: Phys. Rev. 131, 1965 (1963).
[4] E. D. PALIK: Appl. Optics 2, 527 (1963).

Table 3.

Determination	Experiment	Comment
Effective mass at band extrema including anisotropy	Cyclotron resonance (microwave)	Extends only ~ 10^{-3} eV from extrema
Effective mass and position of band extrema lying above or below the minimum gap	CR (microwave) with selective optical excitation of carriers from n- or p-type impurities	Extends only ~ 10^{-3} eV from extrema
Effective mass in materials of short relaxation time and/or heavily doped	High field infra-red CR. Free carrier Faraday effect (with reflectivity minimum)	No anisotropy observable
Temperature dependence of effective mass	Free carrier Faraday effect	No anisotropy observable
Exploration of band shape (non-parabolicity) away from extrema	Free carrier Faraday effect with heavy doping	Only low field theory. No anisotropy
	CR (infra-red with high fields)	Need high field theory
	Interband magneto absorption (IMO)	Involves both valence and conduction bands. Thin samples
Energy gaps	IMO	Convergence plot against B
Effective mass at direct gap minima when indirect gap is smaller	IMO	Involves valence band
Conduction band g-factors	IMO Resonant interband Faraday effect	
Study of light hole and heavy hole valence states	IMO	Using various orientations of B
	Resonant interband Faraday effect	Opposite sign of rotation
Very deep levels, or where absorption is high	Interband magneto reflection	Particularly for semimetals
Relaxation times:		
I. Free carriers	Free carrier ellipticity and Faraday rotation combined	
II. Interband processes	Combination of resonant interband Faraday effect and Voigt effect	

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Sachverzeichnis.

(Deutsch-Englisch.)

Bei gleicher Schreibweise in beiden Sprachen sind die Stichwörter nur einmal aufgeführt.

Subject Index.

(English-German.)

Where English and German spelling of a word is identical the German version is omitted.

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